ADVANCE COPY

SCIENCE

9 September 1955

Volume 122, Number 3167

Editorial

Reserve Forces Act of 1955 451

Articles

Radioactive Fallout from Bomb Clouds: *H. L. Andrews* 453

Glucagon as a Regulator of Insulin Function: *G. E. Anderson* 457

J. P. Marble, Research Geochemist: *W. E. Smith* 459

News of Science

Jarmo Expedition; Survey of Graduate Students; News Briefs; Scientists in the News; Necrology; Education; Grants, Fellowships, and Awards; In the Laboratories; Miscellaneous 460

Reports and Letters

Study of Tumor Cell Populations by Monte Carlo Methods: *J. G. Hoffman, N. Metropolis, V. Gardiner* 465

Nonbicarbonate Buffers in Cell Culture Media: *H. E. Swim* and *R. F. Parker* 466

Substrate Specificity of Peroxidase: *R. R. Fergusson* and *B. Chance* 466

Tetrapod Limb: *D. W. Ewer* 467

Effect of Hematoporphyrin on X-radiation Sensitivity in *Paramecium*: *F. H. J. Figge* and *R. Wichterman* 468

Mucunain, the Active Pruritogenic Proteinase of Cowhage: *W. B. Shelley* and *R. P. Arthur* 469

Metabolism of 3,4-Benzopyrene: *I. Berenblum* and *R. Schoental* 470

Attempt to Reproduce Some of Moewus' Experiments on *Chlamydomonas* and *Polytoma*: *F. J. Ryan* 470

Book Reviews

Electroacoustics; A Million Random Digits with 100,000 Normal Deviates; Endothelium; Antibiotics Annual 1954–1955; The Chemistry of Synthetic Dyes and Pigments; Organic Reactions; Electrolyte Solutions; Papirova Chromatografie; The Method of Trigonometrical Sums in the Theory of Numbers; Preservation and Transplantation of Normal Tissues; Books Reviewed in *The Scientific Monthly*; New Books; Miscellaneous Publications 471

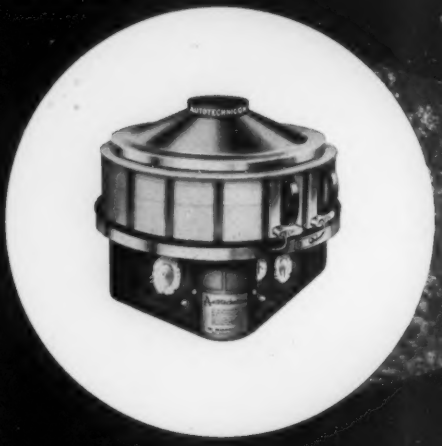
Scientific Meetings

French Association for the Advancement of Science; Meeting Notes; Forthcoming Events 475

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

announcing

new



1 Autotechnicon mono

This new single-deck model is as dramatic in improved efficiency as it is radically different in appearance from earlier Autotechnicons.

models

2 Autotechnicon duo

Boon to the busy laboratory . . . processing or staining at will without annoyance of shifting beakers.

of the

Autotechnicon®

hallmark of excellence in automatic tissue processing

Write today for Booklet 2-A, for description of these new instruments.

THE TECHNICON COMPANY

Chauncey • New York

designed for the professional...

LEITZ ***LABOLUX*** MICROSCOPE

Scientists, physicians and technicians who must work for long periods with a microscope will appreciate the new Leitz LABOLUX with its *fatigue-free operation, precision optics and unexcelled dependability.*

- Stage—instead of tube—moves for focusing.
- Individual coarse and fine adjustments are combined in a single, clutch-operated control knob.
- All controls including those for the mechanical stage in low position for fatigue-free operation.
- Can be used facing away from observer, for greater accessibility of all controls.
- Pre-aligned substage illuminator or mirror.
- Retractable spring mounts in objectives prevent damage to lens and slides.
- Inclined binocular body tube interchangeable with monocular tube for photomicrography.

Send for **LABOLUX** brochure today.

See and examine the new Leitz **LABOLUX** microscope soon.

E. LEITZ, INC., 468 FOURTH AVENUE, NEW YORK 16, N.Y.
Distributors of the world-famous products of Ernst Leitz, Wetzlar, Germany
LENSES · CAMERAS · MICROSCOPES · BINOCULARS

E. Leitz, Inc., Dept. SC-9
468 Fourth Ave., New York 16, N. Y.

Please send me your brochure on the new Leitz **LABOLUX.**

Name _____

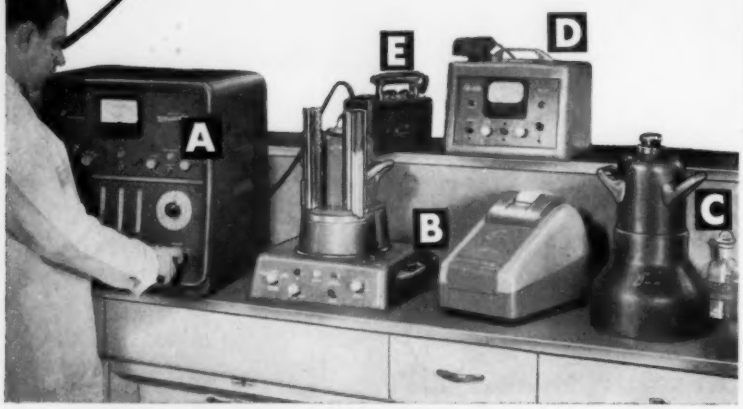
Street _____

City _____ State _____

SCIENCE is published weekly by the AAAS, 1515 Massachusetts Ave., NW, Washington 5, D. C. Entered at the Lancaster, Pa., Post Office as second class matter under the act of 3 March 1879. Annual subscriptions: $7.50; foreign postage, $1; Canadian postage, 50¢.

nuclear-chicago

The ONE source for ALL your nuclear instrument and accessory needs



This radiation counting laboratory includes: A—Scaler, B—Automatic Sample Changer, C—Scintillation Well Counter, D—Count Rate Meter, E—Portable Survey Meter, all made by Nuclear-Chicago.

IT'S SOUND RESEARCH PRACTICE to be sure that the radiation measuring instruments and accessories you use are correctly coordinated to give you maximum efficiency and best laboratory performance. That's why Nuclear-Chicago offers you a complete line of nuclear equipment—instruments matched for maximum versatility and accessories developed for perfect integration with them.

New! Catalog P describes our complete line of radiation measuring instruments, radiochemicals and accessories. Write for your copy today.

nuclear-chicago
237 WEST ERIE STREET
CHICAGO 10, ILLINOIS

NUCLEAR-CHICAGO
237 West Erie St., Chicago 10, Illinois

Please send me Catalog P describing radiation measuring instruments, radiochemicals and accessories.

*Name*_____

*Firm*_____

*Address*_____

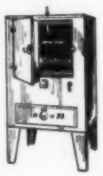
PRECISION makes

the complete line in Research Laboratory Equipment

Precision Scientific Company manufactures a COMPLETE SELECTION or more than 1500 items for use in research laboratories. Quality control and high manufacturing standards at our factory assure you of top performance on any item stamped with the "Precision" name. Always specify Precision when you order items like these:

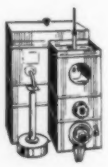
Freas Ovens

Gravity or mechanical convection, floor, table or wall mounting types. Hazard-safe, explosion-proof and vacuum models. Also incubators, sterilizers, conditioning and annealing ovens and humidity cabinets.



Petroleum Testing Apparatus

All types of equipment for the petroleum laboratory. Unique Front-View Distillation Units shown promote accuracy and easier use by centralizing all controls and reading instruments in front. More compact, space-saving design.



Metallurgical Hand Polisher

Ideal for small laboratories or for standardized hand polishing procedures in larger labs. Enclosed drive mechanism and lifetime sealed motor assure long, dependable operation. Exceptionally quiet.

"Time-It" Electrical Stop Watch

Large, legible indicating counter easier to read than conventional watches. Readings to 1/10 second! Can be re-set to zero from any reading or successive readings can be totaled.

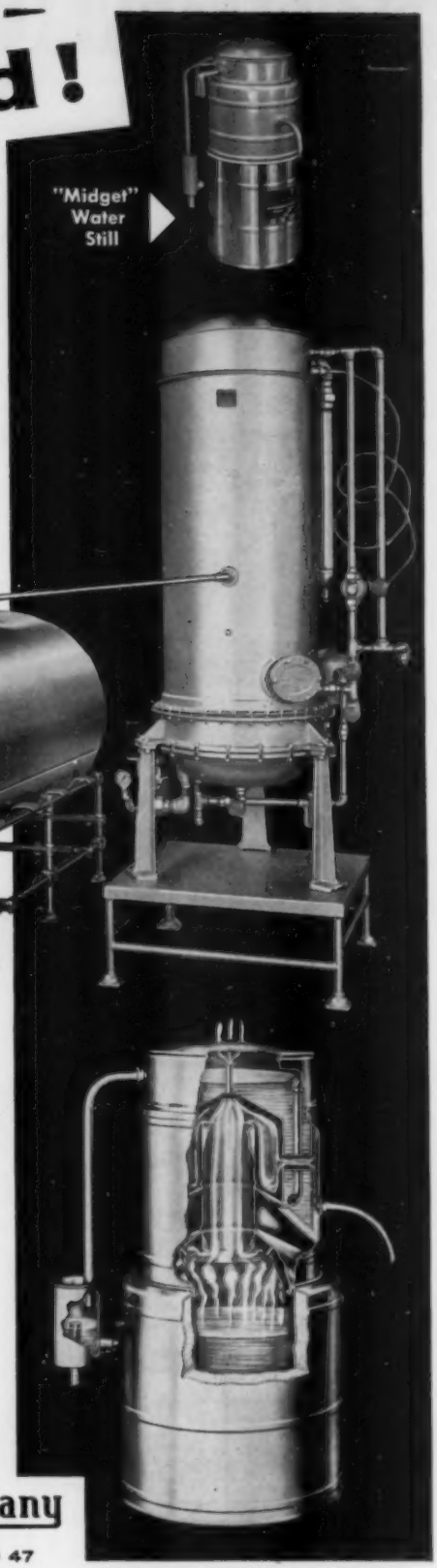
Write for free Bulletins on any of the above equipment.

Precision Scientific Company
3739 West Cortland Street
Chicago 47

*Guaranteed!

The finest in modern research and production control apparatus

*Water Stills *by* PRECISION



PURER DISTILLATE... CERTIFIED

To comply with *all* U.S.P. Standards
To produce pyrogen-free water
To limit total solids to 1 part per million

PURER DISTILLATE...

Over the Years—no small inaccessible condensing tubes that lime up and contaminate water

MORE VOLUME...

Over the Years—no constricted areas to clog and reduce output

LESS ATTENTION...

Over the Years—easily disassembled for inspection. Sectionalized for maintenance convenience

LOWER COST...

Over the Years—as low as .6¢ per gallon because of pre-heated condenser water, large wide-open efficiently formed condensing surfaces

All models are hard water stills

From a Trickle to a Torrent—it's 100 to ½ (gallons per hour) we can meet your capacity requirements...from stock in a great majority of models.

BULLETINS detailing facts covering performance and construction available on request. Just ask for any or all covering the "MIDGET" WATER STILL, the LABORATORY "STREAMLINER" or INDUSTRIAL WATER STILL lines.

Precision Scientific Company

3739 WEST CORTLAND STREET • CHICAGO 47

SENSATIONAL OPTICAL BARGAINS

See the Stars, Moon, Planets Close Up!

BUILD A BIG 100 POWER, 3" REFLECTING TELESCOPE

. . . with This Complete 87 Piece "Do-It-Yourself" Kit

Everything you need! No machining! Easily assembled! We furnish complete, simple instructions. Kit includes: 3" f/10 aluminized and overcoated Spherical Mirror—60X Eyepiece and 100X Barlow Lens—Crossline Finder—sturdy 40" tripod—fork type Equatorial Mount with locks on both axes—ventilated 3" Mirror Mount—heavy wall, black Telescope Tube. All nuts and bolts supplied. Nothing extra to buy. Our 3" spherical mirror (30" f.l.) is guaranteed to resolve detail right up to theoretical limit. Your finished scope can also be used terrestrially. Money back guarantee. Shipping weight—10 lbs.

Stock No. 85,025-W ..... **$29.50 f.o.b. Barrington, N. J.**

LOOK! INFRA-RED ITEMS!

INFRA-RED LIGHT and ITS USES

16 page illustrated Booklet dealing with all phases of Infra-Red projects—including Telescopes, Infra-Red microscopy-photography, watch-dog systems and communications. Includes list of materials.

Stock No. 9040-W ..... **75¢ Pstpd.**

INFRA-RED FILTERS — 5⅜" dia.

For use with infra-red telescopes, camera attachments, etc. Light from a 100-watt bulb passing through the filter is transformed to infra-red light source. Used on jeep headlights with infra-red driving instruments. ⅛" thickness.

Stock No. 60,033-W ..... **$2.00 ea. Pstpd.**

INFRA-RED IMAGE TUBE

Used inside an infra-red telescope, this miniature tube converts infra-red rays to visible rays on the tube screen, which is viewed by an ocular. British import. Cylindrical shape, approximately 2" diameter, 1⅝" long. Requires standard vibra-pack electrical source.

Stock No. 50,046-W ..... **$7.95 Pstpd.**

Check, Measure
Inspect with Handy

6X POCKET COMPARATOR

Measures Linear Dimensions, Angles, Radii, Diameters!

Instant direct measurement of small parts, mechanisms, irregular items, soft rubber, stains, deposits, textiles! Linear dimensions in decimal inches and millimeters. Holes to .005" diameter! 6-power magnification. Triplet lens for wide, flat field, accurate to edge. Clear plastic base admits light. Cell anodized metal. Focus adjustment. Complete with leather case. Order by Stock No.

Size 1½"x2" Approx.

STOCK NO. 30,061-W ..... **$24.50 Postpaid**

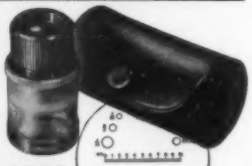
SPECTRAL LAMPS The Famous German OSRAM SERIES

SPECTRAL LAMPS (famous German Osram Series) Used in instruments requiring a monochromatic light source or a segment of the spectrum. All lamps fit a standard medium prefocus socket. Supply voltage: 220 A.C. Amperage: 1.0 to 1.5.

Stock No.	Vapor	Price Pstpd.	Stock No.	Vapor	Price Pstpd.
50,054-W	Cadmium	$29.20	50,060-W	Sodium	$29.20
50,055-W	Cesium	29.20	50,061-W	Neon	29.20
50,056-W	Helium	29.20	50,062-W	Rubidium	29.20
50,057-W	Mercury	29.20	50,063-W	Thallium	29.20
50,058-W	Mercury Cadmium	32.30	50,064-W	Zinc	29.20
50,059-W	Potassium	29.20	50,065-W	Mercury Sulphide	38.48

MEASURING MAGNIFIER

For Checking Inspecting, Measuring



6 power magnification. Size 2" x 1". Extremely accurate right out to edge of field. Reticle pattern etched *on glass* for permanence. Positively not a cheap film reticle. Linear dimensions in decimal inches from 0 to ⅛" in steps of .005". mm scale from 0 to 10mm in steps of .2mm. Measures thicknesses from .002" to .007". Holes from .005" dia. to .050". Instrument comes in protective, genuine leather case.

Stock #30,169-W complete (no extras to buy) ..... **$12.50 Pstpd.**

$12.50 Pstpd.

ASTRONOMICAL TELESCOPES
Completely Assembled

3" REFRACTOR TELESCOPE—40X, 90X and 100X! Complete with equatorial mount, tripod and prism finder! Erects image at all powers. Built in filters.

Stock No. 85,019-W ..... **$195.00 F.O.B.**

4¼" 'PALOMAR JR.'—REFLECTING ASTRONOMICAL TELESCOPE. Complete with tripod. Combination eyepiece gives 57X and 115X. Mirror F/11.

Stock No. 85,006-W ..... **$74.50 F.O.B.**

6" REFLECTOR ASTRONOMICAL TELESCOPE WITH TRIPOD. Equatorial mount Pyrex Parabolic mirror—60X and 120X eyepieces.

Stock No. 85,024-W ..... **$245.00 f.o.b.**

OPTICAL KITS

3" MIRROR TELESCOPE KIT—This kit makes up into a fine little astronomical telescope, easy to make, easy to use! We supply the mirror, focal length 30", ground and polished to ¼ wavelength, aluminized and overcoated with silicon monoxide. Eyelenses for 1" focal length eyepiece. Diagonal. No metal parts.

Stock No. 50,081-W ..... **$10.95 Pstpd.**

"MAKE-YOUR-OWN" 4¼" MIRROR KIT

The same fine mirror as used in our "Palomar Jr." telescope. Polished and aluminized, lenses for eyepieces and diagonal. No metal parts.

Stock No. 50,074-W **$16.25 Pstpd.**

6" "GRIND-YOUR-OWN" ASTRONOMICAL TELESCOPE KIT—Build instrument worth up to $500.00. Grind your own mirror. Contains: mirror blank, eyepiece lenses, diagonal, abrasives, etc.

Stock No. 70,004-W ..... **$11.40 Pstpd.**

50-150-300 Power

MICROSCOPE

Low Price Yet Suitable for Classroom Use! Only $14.95
3 Achromatic Objective Lenses on Revolving Turret!

Imported! The color-corrected, cemented achromatic lenses in the objectives give you far superior results to the single lenses found in the microscopes selling for $9.95! Results are worth the difference! Fine rack and pinion focusing. **Stock No. 70,008-W** .. **$14.95 Postpaid**

SPITZ JR. PLANETARIUM

Latest model! Projects nearly 400 stars, more than 70 constellations in their correct relationships. Use it in any darkened room of the house, project it on the ceiling. No batteries, works on ordinary household current. Rheostat control for brightness. About 14" high on a 7" base. Projection sphere 7" diameter. Weight 3 lbs. 32-page book included free of extra cost. Contains valuable information about the stars, provides easy identification of the constellations. Also included **FREE**—Illuminated pointer which plugs into Planetarium.

Stock No. 70,040-W .... **$14.95 Postpaid**

New! 2 in 1 Combination!
Pocket-Size

50 POWER MICROSCOPE and 10 POWER TELESCOPE

ONLY **$4.50** ppd.

Useful Telescope and Microscope combined in one amazing, precision instrument. Imported! No larger than a fountain pen. Telescope is 10 Power. Microscope magnifies 50 Times. Sharp focus at any range. Handy for sports, looking at small objects, just plain snooping.

Order Stock #30,059-W **$4.50 ppd.**

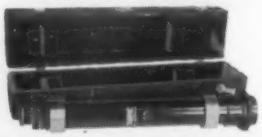
OPTICAL COLLIMATOR

Consists of a large cemented achromat, 5" in diameter, with a focal length of approximately 25", a pin point reticle lighted by a 6–8 volt bulb (to represent a star), a first-surface mirror to reflect the light from the reticle. Overall length 14⅝"; width of cradle 7⅝". Slightly used, but guaranteed in good working order. Shpg. wt. 15 lbs. **Stock No. 80,025-W**

$95.00 f.o.b. Barrington, N. J.

U. S. GOV'T COLLIMATOR

MADE BY ANSCO
Gov't Cost (est.) $200.00



Used to provide a source of infinitive light on which to focus an instrument at infinity. Useful in designing or testing, for setting diopter scale or for many optical tests. Very sturdy brass construction. 2" achromatic lens, F. L. 15¼". Main tube O. D. 3", length 17⅝". Dia. of heavy brass machined mounting rings 2½". Metal crossline slit reticle on dark field. Carrying case included. Brand new.

Stock No. 70,050-W ..... **$35.00 postpaid**

WRITE FOR FREE CATALOG-W

Huge selection of lenses, prisms, war surplus optical instruments, parts and accessories. Telescopes, microscopes, binoculars. Hand spectroscopes, reticles, mirrors, Ronchi rulings, dozens of other hard-to-get optical items. America's No. 1 source of supply for Photographers, Hobbyists, Telescope Makers, etc.

Ask for catalog W

ORDER BY STOCK NUMBER . SEND CHECK OR MONEY ORDER . SATISFACTION GUARANTEED!

EDMUND SCIENTIFIC CORP., BARRINGTON, NEW JERSEY

for new horizons in

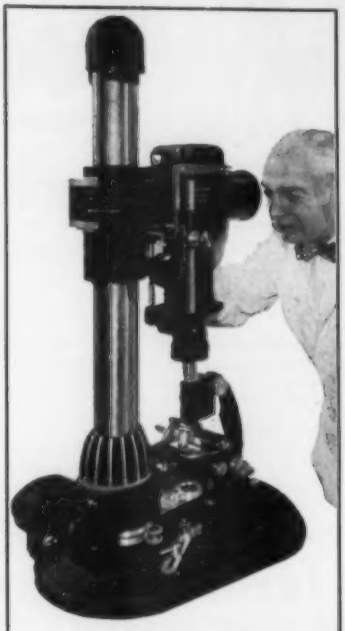
Photomicrography
& scientific photography

The Orthophot

Designed for the ultimate in versatility, the Silge & Kuhne ORTHOPHOT provides all the facilities for still and cine photomicrography (using any standard microscope), photomacrography, photocopying, microfilming, x-ray copying, and general laboratory and clinical photography.

Accessory units not shown include microprojection viewer with 8" x 8" vertical ground glass, alternative electronic exposure meters approximately 20 and 2000 times as sensitive as standard commercial types, and bellows-extension adapters to increase magnification or establish fixed ratios.

This versatile equipment is supplied either in complete assemblies, or in separate sections to coordinate with existing laboratory facilities.



HIGH-POWER PHOTOMICROGRAPHY (50 – 2000 x)

ORTHOPHOT set up with standard compound microscope. Built-in, permanently aligned light source on the Koehler principle, with complete color and intensity controls. Detachable, precision reflex camera has SPLIT-MICRON focusing device.

PHOTOGRAPHY OF GROSS OBJECTS

Object table, oblique extension arm, and standard photo lens convert the ORTHOPHOT for photographing of gross objects, photocopying of papers, drawings, etc. Special table used for trans-illumination, X-ray copying, etc.

LOW-POWER PHOTOMICROGRAPHY (1.5 – 35 x)

In seconds, the ORTHOPHOT converts for low-power photomicrography. Adjustable stand replaces microscope. Same built-in illumination and SPLIT-MICRON focusing used.

GENERAL, CLINICAL PHOTOGRAPHY, Etc.

The ORTHO-CAMERA, detached from column, serves efficiently for all-around laboratory, clinical, as well as outdoor photography. Object distances, from one inch to infinity. Any ratio of reduction; magnification up to 35X for close-ups.

CINE-PHOTOMICROGRAPHY

Almost all 8 and 16-mm cine cameras can be attached to standard column, or interchangeable simplified column on ORTHOPHOT (illustrated), as can many types of standard still cameras, 35-mm to 4" x 5".

— *NEW* — ORTHO-ILLUMINATOR B

OPTIMUM RESOLVING POWER . . . HIGHEST USEFUL MAGNIFICATION

The new ORTHO-ILLUMINATOR B (illustrated), converts any make or model microscope into an integrated unit, with built-in illumination on the Koehler principle. Designed primarily for visual microscopy, or for use with existing photomicrography equipment, the new unit offers unequaled versatility for instant command of proper illumination, for brightfield, darkfield, phase contrast, polarizing or fluorescent accessories.

— Write for descriptive data —

SILGE & KUHNE

16th and Carolina Streets
San Francisco 19, California

AEL "104" LABORATORY STIMULATOR

Precision . . . Versatility

Designed for Success in your most Difficult Problems.

IT'S ACCURATE
Precise fine controls. Multiturn linear potentiometers allow resetability to 0.1 percent. All parameters are stable to 1 percent or better over long periods.

IT'S DEPENDABLE
Designed to be virtually independent of tube changes or circuit ageing.

IT'S RELIABLE
Calibrated for DIRECT READING using simple multiplying factors. "Lock-Tite" fine-control dials prevent accidental change of settings.

IT'S RUGGED
25 watt output at 250 volts permitting DIRECT use of accessories through Front-Panel-Plug, such as the AEL 112 ISOLATOR, various magnetic devices and many other special purpose elements.

Stimulus output is reversible by front panel switch.

ONE AEL "104" gives you FOUR modes of operation without using external synchronization or control systems:

1. SINGLE SHOCKS.....10 μs to 1 second
2. REPETITIVE STIMULI.....0.1 cps to 10 kc/s
3. SINGLE TRAINS OR PAIRS OF STIMULI..100 μs to 10 seconds
4. REPETITIVE TRAINS OR PAIRS OF STIMULI 100 μs to 10 sec.

American Electronic Laboratories, Incorporated

641 ARCH STREET, DEPT. 22, PHILADELPHIA 6, PENNSYLVANIA

Well Scintillation Counter

MODEL CS-600 provides low background (150-200 cpm) for low activity gamma samples.

NRD Instrument Co.

6427 Etzel Ave.
St. Louis 14, Mo.

formerly Nuclear Research and Development

*The Radimax Counter offers more than 20 different counting systems**

NOW...ONE UNIVERSAL SCINTILLATION COUNTER

Solves ALL Your Counting Problems

Directional Gamma Counter

MODEL CS-100 shielded collimated detector with variable aperture for small areas or sample counting. Can also be used unshielded.

Windowless Sample Changer

MODEL CS-5 for sample counting. Alpha, beta and gamma phosphors may be used interchangeably.

All-purpose Survey Unit

MODEL TS-10 utilizes alpha, beta and gamma phosphors.

**Illustrated are just 3 of many counting heads available.*

WRITE TODAY FOR FREE CATALOG AND PRICES.

Improve your lab work

with these HILGER instruments

Hilger Micro-Focus X-Ray Unit

Wide application in both diffraction and micro-radiography. Features low exposure time, high resolution, and provision for utilization of special techniques. Focal spot diameter is of the order of 0.04 mm. Wide range of interchangeable targets. Safety interlock switches eliminate possibility of misuse.

Hilger Recording Infra-Red Spectrophotometer

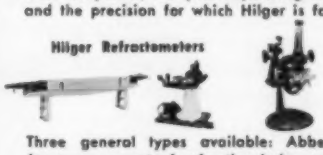
Latest model by the originator of commercial infra-red spectrometers. "Double beam in time" principle alternately feeds radiation from sample and reference beams to the spectrometer. A shutter in the comparison beam automatically compensates for differences in the energy of the two beams and its position is translated by pen recorder. May also be used as single beam instrument for recording emission spectra.

Whether yours is a research, industrial or educational laboratory, you can improve your techniques — and save money, too — by specifying Hilger instruments. From simplest polarimeter to major spectrographic equipment, world-famous Hilger instruments are designed with your needs in mind. So find out what you have been missing. Get complete information on the instruments described briefly here — or any of the many other precision Hilger instruments — by writing for free catalogs.

Hilger Polarimeters

Available in two precision types — Standard Model for research and heavy industrial use and a Small Model for general laboratory or instructional use. Standard Model includes sugar scale so it may be readily used as an accurate saccharimeter. Both instruments include simplified, fool-proof operating features and the precision for which Hilger is famous.

Hilger Refractometers



Three general types available: Abbe type for measurement of refractive index and dispersion in liquids; Chance type for measurement of both solids and liquids; and two types of Rayleigh Interference Refractometers for measurement of liquids or gases. All instruments include important new improvements which simplify their use and assure more dependable results.

Hilger Large Aperture Monochromator

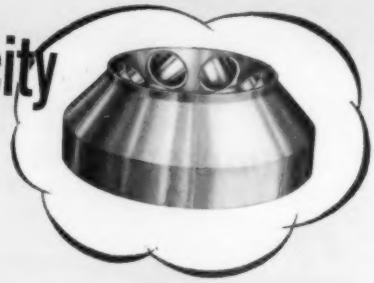
Interchangeable wave length drum scales make this instrument useful both as an efficient infra-red spectrometer with high resolving power and as a single monochromator for the ultra-violet region. Newly designed optical system provides range down to 2000A with quartz prism without loss of aperture. Prisms available in quartz, glass, rocksalt and potassium bromide.

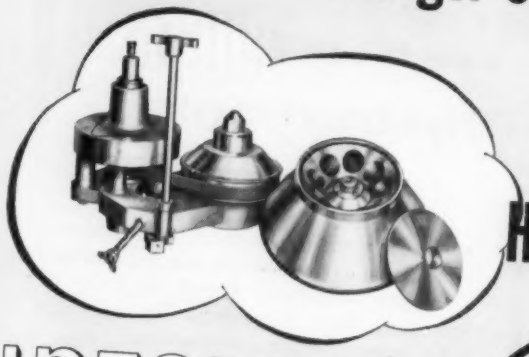
JAco

JARRELL-ASH COMPANY
26 Farwell Street, Newtonville, Mass.

SALES OFFICES Detroit 13680 Capitol Ave. | El Cerrito, Cal. 1344 Devonshire Dr. | Pittsburgh, Pa. 916 Greenhill Rd. | Los Angeles (Duarte) Miltonwood Rd.

Larger Capacity





Higher Speeds with

INTERNATIONAL Refrigerated Centrifuges

NOW — New accessories give the International **PR-2 Refrigerated Centrifuge** these increased speeds and capacities:

400 ml. at 10,000 rpm. at 0°C. or lower
100 ml. at 19,000 rpm. at 0°C. or lower
4000 ml. at 2,300 rpm. at 0°C. or lower
1500 ml. at 3,900 rpm. at 0°C. or lower

PLUS — 24 additional interchangeable angle and horizontal style heads and a wide variety of adapters, sealed accessories and carriers. No other cold centrifuge is so versatile.

SEND — for Bulletin P and information on the **New High Capacity Attachment**, the **New 6-Place 250 ml. Angle Head** and the **New 4-Liter Head.** If you already have an International PR-2, these new accessories will fit.

ALSO — the improved **Model SR-3 Stationary Refrigerated Centrifuge** will now swing 5200 ml. in the horizontal position at 3,000 rpm.

FOR — real versatility in the Refrigerated Centrifuge field — look to **INTERNATIONAL.**

INTERNATIONAL EQUIPMENT COMPANY
1284 SOLDIERS FIELD ROAD, BOSTON 35, MASSACHUSETTS, U. S. A.

9 September 1955, Volume 122, Number 3167

SCIENCE

AMERICAN ASSOCIATION
FOR THE
ADVANCEMENT OF SCIENCE

Board of Directors

GEORGE W. BEADLE, *President*
PAUL B. SEARS, *President Elect*
WARREN WEAVER, *Retiring President*
WALLACE R. BRODE
JOHN R. DUNNING
MARK H. INGRAHAM
PAUL E. KLOPSTEG
CHAUNCEY D. LEAKE
MARGARET MEAD
THOMAS PARK
LAURENCE H. SNYDER
PAUL A. SCHERER, *Treasurer*
DAEL WOLFLE, *Administrative Secretary*

DAEL WOLFLE, *Acting Editor*
CHARLOTTE V. MEETING, *Assistant Editor*

Editorial Board

MARK H. ADAMS
WALLACE R. BRODE
BENTLEY GLASS
KARL LARK-HOROVITZ
EDWIN M. LERNER
WILLIAM L. STRAUS, JR.

Editorial Staff

PEARL BOBIER, CATHERINE H. BORRAS, BEVERLY BUHNERKEMPE, SARAH S. DEES, MARY JANE DOUVILLE, OLIVER W. HEATWOLE, M. DALE HOOPER, YUKIE KOZAI, RUTH MCNEIL, ELLEN E. MURPHY, ROBERT V. ORMES, BETHSABE PEDERSEN, JACQUELYN VOLLMER.

EARL J. SCHERAGO, *Advertising Representative*

SCIENCE, founded in 1880, is published each Friday by the American Association for the Advancement of Science at Business Press, Lancaster, Pa. Entered at the Lancaster, Pa., Post Office as second class matter under the Act of 3 March 1879.

SCIENCE is indexed in the *Reader's Guide to Periodical Literature*.

All correspondence should be addressed to SCIENCE, 1515 Massachusetts Ave., NW, Washington 5, D.C. Manuscripts should be typed with double spacing and submitted in duplicate. The AAAS assumes no responsibility for the safety of manuscripts or for the opinions expressed by contributors.

Change of address: The notification should reach us 4 weeks in advance. If possible, please furnish an address stencil label from a recent issue. Be sure to give both old and new addresses, including zone numbers, if any.

Annual subscriptions: $7.50; foreign postage, $1; Canadian postage, 50¢. Single copies, 25¢. Special rates to members of the AAAS. Cable address: Advancesci, Washington.

The AAAS also publishes THE SCIENTIFIC MONTHLY.

Reserve Forces Act of 1955

The Reserve Forces Act of 1955 has been placed on the statutes, and thus the military manpower program of the nation has been settled for a time—possibly a long time. It seems unlikely that the Congress will open up these touchy issues short of a gathering international storm. The present legislation could be with us a long time.

Nevertheless, few commentators consider it good legislation. It was intended to provide for the building up of an adequate, trained reserve immediately available for service in emergency so that there would not again be need for the sudden recall of veterans, as there was in 1950. At best the new law goes only a short way in this direction. It does provide that those who enter reserve status (after enactment of the legislation) are subject to positive penalties for failure to meet reserve obligations for training, thus putting some teeth into reserve training requirements. It does provide that a limited number (200,000 annually) who are released from active duty after 1 year may enlist in the Ready Reserve and fulfill their military obligation in a shorter time than the 6-year period generally applicable to most young men under the new law. It does permit young men prior to age 18½ to enlist in a reserve component and escape active service, although their total obligation is then up to age 28. Finally, it permits young men up to 18½ years of age to enlist for a period of basic training (3 to 6 months to be determined by the Secretary of Defense) and then to serve in an active reserve program for 7½ additional years.

These several avenues are obviously established in the hope that some or all of these choices may provide a channel of traffic into a burgeoning reserve force capable of meeting the demands of possible military crisis of the future. There is no single provision for what a civil defense crisis might require. It is safe to say that the bill leaves something to be desired.

With respect to specialized personnel, however, the bill registers certain clear gains in national viewpoint on service obligation. It recognizes that the military strength of the nation requires that a due proportion of the critical civilian skills be released for civilian needs. This is manifest in the provision that "members of the Reserve Forces possessing critical civilian skills will not be retained in numbers beyond the requirements for those skills except for persons who have military skills for which there is an overriding requirement" [Sec. 208 (k)(3)]. To insure the above, continuous screening procedures by the Department of Defense are made mandatory.

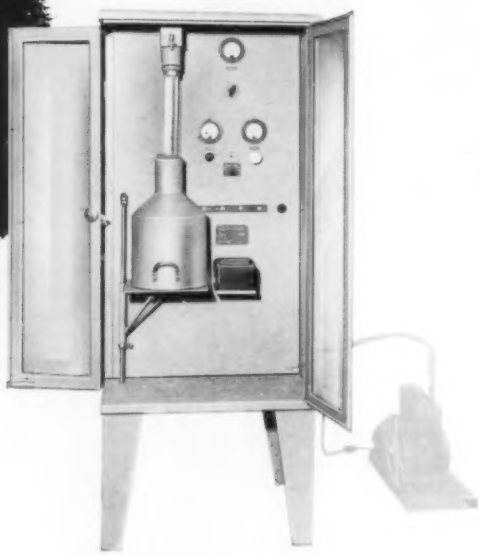
A second provision affecting specialized personnel is Sec. 262 (b)(3). This section adds new features as regards specialized personnel. If under 18½, persons may elect to enlist in a reserve component, take 3 to 6 months training, then join a reserve unit. If they then pursue training in a profession or skill recognized as critical, they may be screened out to the Standby Reserves under the provisions of Sec. 208.

Or, a young man may elect to pursue his studies under the student-deferment program. If he then emerges as a specialist in a category considered to be possessed of critical civilian skills, he may be authorized to enlist in a reserve component, first taking his 3 to 6 months training. Thereafter he becomes subject to screening to the Standby Reserve under Sec. 208.

It is notable that, whereas in general throughout the legislation regulations are prescribed either by the Secretary of Defense or the appropriate secretary of one of the armed forces, in Sec. 208 and Sec. 262 the act specifically lodges this authority in the President.

Obviously, much of the significance of these provisions will depend on the manner and the spirit of their administration. It is, therefore, worthy of note that the intent of the Congress, as indicated by the remarks of Congressmen in the various hearings on the bill, is unusually clear, even though the actual wording of the legislation seems not to depart so drastically from the past. Indications are that the administration is prepared to follow in the lead of Congress in this respect.—M. H. TRYTTEN, *Office of Scientific Personnel, National Academy of Sciences–National Research Council, Washington, D.C.*

For tissue freezing problems



CRYO-DESICCATOR

For use in Histology—Cytology—Histopathology—Cytochemistry—Histochemistry

. . . provides a simple, rapid, reliable and inexpensive method of preparing frozen dried tissues. . . . Temperature is measured under same conditions as the tissue, cooled by liquid nitrogen. Automatic sealing is achieved by atmospheric pressure. Rugged construction.

Cat. No. 9-99 **Price $1450.00**

FURNISHED WITH
THE FOLLOWING ACCESSORIES:

- 1 extra glass tube for tissue heater
- 1 electric cord
- 1 flexible metal tube for attaching to pump
- 1 dial thermometer, Weston 0-180 Deg. F.

FREEZE DRIER

This is a simple compact unit that maintains the efficiency obtained in many of the more elaborate Freeze Driers that are now on the market. It can be operated in conjunction with any standard high vacuum pump, such as, the Bird-Nelson pump.

Catalog No. 9-97 **Price $175.00**

PHIPPS & BIRD, INC.

MANUFACTURERS AND DISTRIBUTORS OF SCIENTIFIC EQUIPMENT

6TH & BYRD STREETS — RICHMOND, VA.

9 September 1955, Volume 122, Number 3167 SCIENCE

Radioactive Fallout from Bomb Clouds

Howard L. Andrews

There has been considerable public interest, and not a little apprehension, since the announcement that some of the inhabitants of the Marshall Islands had been exposed to radioactive fallout from one of the weapons tested in the Pacific in the spring of 1954. The wide variety of reactions to this announcement indicates a lack of detailed information about the mechanisms by which fallout particles are produced and about the biological implications of the radioactivity associated with the particles. Scientific data are not now available to answer all questions with certainty, but some features are sufficiently well understood to warrant public presentation.

Fallout is not a new thing to those charged with the responsibility for conducting tests of nuclear weapons. From the time of the first nuclear detonation at Alamogordo, N.M., it was clearly recognized that the now familiar stem-and-mushroom cloud contains enormous quantities of radioactive isotopes. Some of the radioactive material in the cloud will fall to the surface of the earth before it has decayed to stable forms, and it will produce areas of radioactive contamination. Monitoring teams followed the Alamogordo cloud and found some desert areas moderately contaminated with radioactive fallout.

At Operation Greenhouse, conducted at Eniwetok Atoll in 1949, a wind shift brought a portion of a bomb cloud over the testing area, and the atoll received fallout over a period of several hours. Detailed measurements were made of the radiation doses received by the task force personnel, and there seemed to be no reason to consider evacuation from the atoll.

When peacetime weapons testing was authorized within the continental United States, the fallout problem was recognized, and an advisory panel was set up to advise the test manager and test director on all matters of public safety. Such a group has considered and approved every shot fired at the Nevada Proving Ground. Each panel is made up of specialists in the fields of atomic medicine, radiation health protection, blast, and meteorology. The panel has a changing membership but has included such capable men as John Bugher, AEC; J. P. Cooney, U.S. Army; and Shields Warren, Deaconess Hospital, Boston. The U.S. Public Health Service has had a representative on each panel.

Each detonation is carefully considered by such a panel several times before the firing. The first detailed consideration typically occurs about 24 hours before shot time. The expected blast and radiation are evaluated in terms of the predicted meteorology, and the shot is either "on" or "off." If it is "on," a second evaluation of both on-site and off-site hazards is made at minus 8 hours. Better weather forecasts are then available and a sounder judgment can be made. From then until shot time the panel may be in almost continuous session, watching for unfavorable meteorological developments that might call for a postponement. Winds are notoriously fickle, and even with this very careful study the radioactive debris may not go in the expected direction. A substantial error is anticipated, however, and only a very poor weather verification can lead to a situation requiring more than routine precautionary measures.

The biological hazards associated with fallout can be better appreciated with a clear understanding of the nature and mechanism of formation of the fallout particles. When an atomic bomb is detonated, nuclei of the fissionable material, U^{235} or Pu^{239}, are split into two approximately equal parts, the splitting taking place in any one of 30 or 40 different ways. The fission-product nuclei thus formed range over the middle of the periodic table from about zinc (atomic number 30) to europium (atomic number 63). The fission-product nuclei have an excess of neutrons and consequently are unstable. They emit beta particles, followed in many cases by gamma rays. After a series of successive beta-particle emissions, the neutron excess is relieved, and each fission chain terminates in a stable isotope that presents no hazard.

In a typical fission $_{92}U^{235}$ splits into $_{40}Zr^{97}$ and $_{52}Te^{137}$, both of which then undergo radioactive decay:

$$_{40}Zr^{97} \rightarrow {}_{41}Cb^{97} \rightarrow {}_{42}Mo^{97}$$
17 hr 75 min stable

$$_{52}Te^{137} \rightarrow {}_{53}I^{137} \rightarrow {}_{54}Xe^{137} \rightarrow$$
1 min 22 sec 3 min

$$\rightarrow {}_{55}Cs^{137} \rightarrow {}_{56}Ba^{137}$$
27 yr stable

Each isotope decays with its characteristic half-life, which may be as short as a fraction of a second or as long as many years. The composite fission-product mixture, composed of more than 100 active isotopes, has no half-life, as ordinarily defined, but shows an activity that decays according to the expression $1/t^{1.2}$. As decay proceeds, elements of short half-life essentially disappear; old fission-product mixtures consist primarily of long-lived isotopes. Twenty-year Sr^{90} is one example of a long-lived fission product occurring with a rather high yield.

Most data on weapons performance are given in terms of a "nominal" bomb of 20 kilotons, which is to say a weapon with an explosive power equal to that derived from the detonation of 20,000 tons of TNT. Table 1 lists the gamma-ray activities of the fission products from a nominal detonation as a function of time after detonation (*1*). These figures seem appalling when one remembers that the unit of activity, the curie, is the rate of disintegration of 1 gram of radium, and that rather elaborate precautions are taken in handling even a few millicuries of radioactive materials. The situation appears overwhelming when these figures are scaled up for weapon sizes greater than that of the nominal bomb. For example, simple scaling from 20 kilotons

Dr. Andrews is head of the general radiobiology section of the National Cancer Institute. This paper is adapted from an address given before the Washington Academy of Medicine 13 May 1955.

to 2 megatons means an increase of activities by a factor of 100, which would result in a figure of 8.2×10^{13} curies 1 minute after detonation. The figures must, however, be considered in the light of the exact method for formation and subsequent fate of the fission products responsible for the radioactivity.

Each fission process is an independent event, and consequently fission products are formed as individual nuclei in a state of aggregation quite different from that in which they are usually observed. When a nuclear device is detonated, all the energy is released in a very short time, measured in millionths of a second. As a consequence, the temperature of a relatively small volume rises to fantastic levels, and all material in this "fireball" will exist as a gas. All the fission products and, consequently, all the radioactivity (if we except that activity induced locally by escape neutrons) are inside the high-temperature fireball.

The fireball, being less dense than the surrounding air, will rise to great heights, just as a hot-air balloon rises until it is in equilibrium with its environment. The cloud from a nominal bomb may rise to an altitude of 40,000 feet at an initial rate of 200 miles per hour (*1*). As long as the fission products remain at this altitude, no hazards are to be anticipated at the surface of the earth. Intensity attenuation by the inverse square law and atmospheric absorption will reduce radiation levels at the earth's surface to insignificant values. Although it would be unwise to linger near the cloud in its early stages, passage through the cloud is not necessarily a fatal operation. Ten minutes after detonation, a passage through the cloud at 300 miles per hour would result in a radiation dose of about 25 roentgens (*1*), which is about one-twentieth of the median lethal dose for man. Some fission products might adhere to the plane and raise the dose somewhat, but the dose would probably not be doubled.

In the simple case we have been considering, fallout, or the return of the radioactive materials to the earth's surface, will be greatly delayed or may not take place at all. In still air particles fall under the force of gravity according to Stokes' law, which requires that the speed of fall increase rapidly with particle size. Thus 70 days will be required for a 5-micron particle to fall 40,000 feet, while a 16-micron particle will fall the same distance in 7 days. Atmospheric turbulence complicates the practical situation, but it is evident that very small particles will remain at high altitudes for long periods of time. There will, therefore, be a negligible fallout hazard associated with a "clean" detonation as described.

Table 1. Gamma-ray activities from a 20-kiloton detonation.

Time after detonation	Activity (c)
1 min	8.2×10^{11}
1 hr	6×10^{9}
1 day	1.33×10^{8}
1 wk	1.3×10^{7}
1 mo	2.3×10^{6}
1 yr	1.1×10^{5}
10 yr	8×10^{3}
100 yr	6×10^{2}

The situation will be quite different if the detonation occurs at a low altitude, so that the fireball intersects the surface of the earth. There is then an opportunity for a thorough mixing of the gaseous fission products with dust and dirt from the earth or with the debris from shattered buildings. The hot cloud will rise as before, creating a low-pressure area behind it. There will be an inward rush of dust-laden air to relieve the low pressure, and a jet or column of particulate matter will rise beneath the cloud. The jet may overtake the cloud and mix with it, thus providing another chance for intimate contact between the atomic-sized fission products and macroscopic particles. During the mixing and cooling, many fission fragments will condense onto the particles; the rate of fall will then be determined by the size distribution of the particles rather than by the characteristics of the fission fragments.

Large, visible particles may fall out in a matter of minutes to produce the radioactive "snow" reported during the Pacific operations in 1954. Smaller particles will be carried away by the prevailing winds, to dribble down along the path of the cloud at places determined by each particle size. We thus have a contaminated area downwind from the point of detonation, of a shape and size determined by meteorological conditions. Each fallout pattern will present a unique situation, and general conclusions can be drawn only by making some reasonable assumptions.

Obviously, early fallout will be more serious than late, for there has been less chance for radioactive decay. We will consider the situation at plus 1 hour when fallout will under average conditions be occurring at distances of 20 to 25 miles from the point of detonation. If 1 million curies of activity are spread over 1 square mile, the resulting gamma ray dose rate will be about 8 roentgens per hour (*1*), and from the properties of fission-product decay we calculate that this will give an "infinity" dose of 40 roentgens. Infinity dose is the total radiation dosage received by an individual who was in the area when fallout occurred and who remained there for an infinite length of time. The calculation of infinity doses tends to exaggerate the hazard, but not seriously, for a relatively large fraction of the infinity dose is received in the first few days.

Detailed data on chronic irradiation effects are not available, but 40 roentgens is certainly not lethal. An infinity dose of 1000 roentgens, resulting from the deposition of 25 million curies per square mile, would undoubtedly be a serious hazard to occupants of the contaminated area. If all the activity from a nominal bomb came down at plus 1 hour we could expect the serious contamination of about 200 square miles. Extrapolating as before by a factor of 100, we arrive at 20,000 square miles of potentially dangerous fallout area for a hypothetical 2-megaton burst. These figures do not, of course, represent the actual situation, since uniform distribution is never attained.

The calculated areas are obviously too large, because by Stokes' law only particles larger than 200 microns can fall 40,000 feet in 1 hour. Many of the cloud particles will be smaller than this and will remain suspended for longer periods of time. It is probably realistic to reduce these figures by a factor of 100 to take care of this fact and the decrease in radiation intensities owing to weathering and the shielding effects of normal dwellings. With this factor of ignorance, the potentially dangerous areas shrink to 2 and 200 square miles, respectively.

These figures represent areas where survival is the criterion of acceptability and where only the effects of external penetrating radiation are considered. They are of interest in assessing possible effects of an enemy attack with nuclear weapons but are obviously not applicable when considering the peacetime testing of nuclear devices where national survival is not immediately at stake.

Before considering the peacetime situation it will be well to review briefly presently accepted standards for radiation exposure in industry. At the present time the National Committee on Radiation Protection recommends (*2*) that whole-body exposure not exceed 0.3 roentgen per week for personnel planning to work with radiation for long periods of time. This level allows a total yearly dose of 15.6 roentgens, but integration of the weekly dose is not recommended. That is, one should not plan to receive his yearly dose of 15.6 roentgens in 1 week, even though no further exposure is contemplated during the subsequent 51 weeks.

The 0.3 roentgen per week criterion is quite satisfactory for day-by-day exposures in the laboratory or in industry but is seriously restrictive to a weapons-testing program. Here, radiation exposure necessarily comes at irregular intervals, with maxima occurring after each contaminating detonation. The Atomic

Energy Commission has taken what appears to be a realistic approach to this problem. On the one hand they have reduced the allowable annual dose by a factor of 4 to 3.9 roentgens, and on the other hand they allow this to be received at any rate or over any period of time. Thus a single detonation might, because of adverse wind changes, result in a fallout pattern that would deliver 3.9 roentgens to a given community. If this is the case, that community has used up its yearly radiation allotment, and extreme care must be taken by the test group to insure that no further fallout is received there for at least 1 year.

During test operations at the Nevada Proving Ground an elaborate off-site monitoring program is maintained, manned by U.S. Public Health Service personnel, and careful records are kept of all radiation exposures up to at least 200 miles downwind from the test site. Experience has shown that beyond this range decay has reduced the radioactivity to levels incapable of exceeding the established exposure limits. It is true that fallout is readily detectable well beyond the 200-mile radius and that some people have been disturbed by traces of activity found on the east coast of the United States.

An examination of the records shows that the criteria laid down by the AEC have been well met. Large numbers of people have not been exposed to high levels of radiation, and if the 0.3 roentgen per week were the only criterion we could conclude that there had been no radiation injuries as a result of the continental test program.

Three other aspects of radiation hazards remain to be considered before a final conclusion can be drawn concerning both the safety of weapons test operations as now conducted and the radiological hazards to be anticipated from an enemy attack with nuclear weapons. The 0.3-roentgen-per-week figure is based on the assumption that all the radiation is received from external sources, with no radioactive materials entering the body by any route. This can scarcely be the case for a fallout exposure, for during the period of actual fallout there will be radioactive particles in the air at all altitudes from the surface of the earth to the height of the bomb cloud. The possibility of beta-particle burns and injury from particle inhalation must be considered.

During fallout, radioactive particles will settle out on the exposed skin of anyone outdoors, and the hazard of beta-particle burns is added to that arising from the more penetrating gamma rays. Beta particles from fission products travel through only a few millimeters of tissue and, consequently, do not produce the generalized injury associated with more penetrating radiations. However, beta particles give up all of their energy in a very short distance and hence the amount of ionization in the superficial layers of tissue will be relatively large. Beta-particle burns resulting from fallout are well known, the earliest example being the cattle contaminated from the detonation at Alamogordo.

A number of cattle about 10 miles from the Alamogordo blast received fallout on their backs. The fine fallout particles were retained by the hair, and in a few weeks epilation occurred and blister-like lesions developed. The lesions healed much like ordinary thermal burns, and hair grew again, although the original red color was replaced with white or gray. These animals have been carefully observed for several years and show no radiation effects other than the graying of the hair. The cows produced a normal number of calves and these, in turn, appear to be normal in all respects.

There was some epilation among the Marshall Islanders who received fallout during the 1954 test series. It is interesting to note that in the human cases the new hair returned a deep black color, with no sign of the graying seen in the cattle.

Relatively few data are available for estimating the beta-particle hazard. Unfortunately, most of our knowledge of acceptable radiation dosage must be based on cases of human overexposure. During the half-century of experience with x-rays a considerable number of cases of overexposure have been studied, but the number of well-documented cases of beta-particle exposure is very small. The National Committee on Radiation Protection (*2*) recommends a limit of 1.5 rep (*3*) per week of beta-particle radiation to limited areas such as the hands, and this seems to be a reasonable value for present discussion.

If 13 weeks of integration is allowed, as in the case of gamma-ray exposure, up to 19.5 rep is permissible for a single incident in 1 year. This is a more severe restriction than the allowable penetrating radiation restriction, for the limit has increased by a factor of about 5, while the ionization of tissue has gone up by a factor of 10 or more. Under peacetime testing operations this is not a serious limitation, because relatively simple measures can reduce the beta-particle hazard to negligible levels. The beta-particle hazard is primarily present only during the time when fallout particles are actually reaching the surface of the earth. Once down they contribute to the general activity of the area but do not contaminate skin surfaces to any extent.

Fallout can be readily detected with standard radiation survey equipment, and with an adequate monitoring service populations can be requested to stay indoors during the active phases of fallout if the intensities warrant such precautions. In general this will not prove to be a very disturbing request, for active fallout will usually last less than an hour.

People who have received fallout directly on their skin can remove practically all of the particles by washing or vigorously dry-brushing. An occasional individual is opposed to the use of soap and water, but he can usually be persuaded to wash when the situation is explained to him. Thus it appears that beta-particle hazards associated with test operations can be eliminated by an adequate downwind monitoring system with only minor inconveniences to a few people. People who have inadvertently received fallout on their skin can remove the contamination by washing. The same basic principles, avoidance and decontamination, can be used against larger weapons that may be employed against us. The activity levels will be much higher, and greater areas may be involved, but cover and cleanliness are still the guiding principles for reducing beta-particle hazards.

In considering high levels of radiation resulting from enemy action, one big difference between overexposure to gamma rays and beta particles should be mentioned. Overexposure to gamma rays will be followed by typical signs of radiation injury: weakness, nausea, vomiting, diarrhea, leucopenia, generalized infection, and death. External beta-particles, however, because of limited penetration, do not reach the hematopoetic system and sensitive organs, and signs of general radiation injury are absent. Exposures of a few thousand rep will result in epilation, followed by third-degree burns that may require long hospitalization and extensive skin grafting if late tissue breakdown is to be avoided. With adequate care, however, the inevitable fatal outcome associated with gross overexposure to more penetrating radiation is avoided.

During active fallout the air contains large numbers of slowly falling particles, and it is inevitable that some of these will enter the respiratory system. This has given rise to considerable concern that inhalation hazards may be the most serious aspect of the fallout problem. Lack of data prevents giving exact answers to the questions of inhalation hazard, but a few general comments can be made.

In the first place, only a limited range of particle sizes can enter and be retained by the alveoli. Particles smaller than 0.5 microns behave much like gas molecules and enter and leave the lungs without retention. Normal nasal efficiency in removing particles is practically 100 percent for particles larger than 5

microns, and consequently few of these particles reach the alveoli. The larger particles are removed by ciliary action and are swallowed. Their subsequent fate is determined primarily by the chemical composition of the particles. Some will be absorbed, and others will be excreted almost completely.

It is not possible to give the fraction of the total fission-product activity associated with particles of retainable size, because this will depend upon the size distribution of the particles mixing with the bomb cloud. The distribution will vary with each type of terrain, but in general it is evident that the fraction of particles in the 0.5- to 5-micron range will be small.

Except under very unusual circumstances, early fallout will not consist of retainable particles, because, by Stokes' law, a 5-micron particle requires more than 70 days to fall 40,000 feet. By this time radioactive decay has reduced the total activity by a factor of 7500 from the activity at 1 hour.

As an example, we may cite the results of an experiment in which sheep and dogs were exposed to early fallout of an intensity scarcely to be experienced by any survivors from an atomic attack. In this particular case the fallout cloud was so dense that the animal cages were hidden from view for well over an hour, and deposited fallout was so heavy that recovery operations had to be postponed for 24 hours to avoid overexposure of personnel. The original experimental design was ruined because all animals received a lethal dose of penetrating radiation and had to be killed well ahead of schedule. Hundreds of lung sections from 40 animals were examined and many nonradioactive particles were found. Only 56 particles showed any activity. There was active material in the gut, and some of this presumably came from the swallowing of large inhaled particles, although licking the fur undoubtedly contributed to some extent.

From these considerations it appears to be difficult for enough active particulates to enter the lungs and remain there to produce damaging average radiation doses. It does not follow that there is no radiation hazard, for it is conceivable that a single active particle might be sufficient to induce a radiation cancer. This seems unlikely because the total activity associated with a particle of size less than 5 microns is not great, but proof on this point is lacking. In this connection we may quote from Furth and Lorenz (*4*): "It is now well established that a single local exposure is likely to cause a neoplasm only under exceptional conditions, but a single massive exposure to either X or γ radiation over the entire body may often cause cancers in some internal organs."

Radioactive particles may also enter the body from the use of food or water exposed to fallout. The $Sr^{90} + Y^{90}$ complex is probably the most hazardous fission-product fraction, because it is produced in a good yield, has a long half-life, and tends to be retained by bone. Let us consider the situation previously discussed, where the fission products from a nominal bomb produced a serious external radiation hazard over an area of 2 square miles. It is easily calculated that about 1 kilogram of material must fission in a nominal detonation and that about 50 grams of Sr^{90} will be formed. If all of this Sr^{90} were spread uniformly over 2 square miles there would be about 1 microgram per square foot. About 23 percent of ingested Sr^{90} reaches the bone, and the maximum permissible body burden is 1 microgram (*5*). It appears, therefore, that in an area where fallout is serious because of external dose considerations, one could ingest without serious effects all the fission products deposited on 4 square feet of food. Since fallout particles can be removed from most surfaces by washing, it appears that food need not present a hazard even in heavily contaminated areas.

As an example of a water supply, we may consider Lake Mead, lying in close proximity to the Nevada Proving Ground. Conservatively, Lake Mead contains about 600×10^9 cubic feet of water. If all the fission products from a nominal bomb fell into Lake Mead and were thoroughly mixed, one would have to drink some 50,000 cubic feet of water to reach the tolerance value for Sr^{90}.

The most controversial facet of radiation injury is the possible genetic effect on future generations. This field can be discussed only by specialists, and I shall restrict my comments to a few relatively noncontroversial generalizations.

The fact that there are differences of interpretation of genetic data indicates that the exact situation is not known. It is certain that radiation can readily produce both gene and chromosomal changes and that these changes will tend to be perpetuated by the very nature of genetic materials. It is also certain that radiation can produce changes leading to genetic death in several generations. From data taken primarily on fruit flies, we can predict that a certain number of visible mutants will appear for each roentgen of exposure, and other, less obvious mutations can be inferred. We can predict that the number of genetic injuries will increase with the radiation dose.

Unfortunately, for present purposes, man is not a fruit fly, and extrapolations from fly to man must be modified by man's breeding habits and psychological reactions to a changing situation. It is too early to draw final conclusions from the experiences of Hiroshima and Nagasaki, and in any case these may not provide the real answer.

Decisions of great importance must be taken, decisions that may well affect the fate of mankind to the end of time. We must avoid treading the genetically downward path to the point of no return, to the point where race extinction or degradation is inevitable. We must, however, avoid the hysterical banning of all nuclear experiments likely to produce radioactive fallout.

If a force in being is necessary to maintain our way of life and keep an uncertain peace in a troubled world, then our atomic-weapon stockpile, both in quality and quantity, is a national asset of the first importance. Supremacy, or at worst parity, in nuclear weapons becomes a necessity for an adequate national defense. Granting these premises, a weapons development program becomes an essential part of our defense effort, and obviously such a program requires an adequate testing facility. Proving grounds should then be considered as facilities of considerable national importance and not mere playgrounds for the amusement of bomb-happy scientists.

There is a vast difference between a carefully prepared program for exploding a few nuclear devices under well-controlled conditions, and in such a way as to minimize radiological hazard, and an all-out war with both sides using nuclear devices of all sizes in the most effective and damaging ways possible. If the first alternative helps to prevent the second, we must accept the uncertainty of some information not yet known and take the calculated risk of some radiation injury now in order that we may prevent annihilation later.

References and Notes

1. *The Effects of Atomic Weapons* (Government Printing Office, Washington, D.C., 1950).
2. *Permissible Dose from External Sources of Ionizing Radiation*. National Bureau of Standards Handbook 59 (Government Printing Office, Washington, D.C., 1954).
3. The rep, or roentgen equivalent physical, is a unit used with particulate radiation, comparable to the roentgen and representing the absorption of 93 ergs per gram of tissue.
4. *Radiation Biology*, vol. 1, pt. 2, A. Hollaender, Ed. (McGraw-Hill, New York, 1954).
5. *Maximum Permissible Amounts of Radioisotopes in the Human Body and Maximum Permissible Concentrations in Air and Water*. National Bureau of Standards Handbook 52 (Government Printing Office, Washington, D.C., 1953).

Glucagon as a Regulator of Insulin Function

George E. Anderson

Medical literature has given the impression, apparently an erroneous one, that glucagon is antagonistic to insulin (*1–3*). This view has been fostered by the fact that hyperglycemia can be produced by the hormone. Our group at the State University of New York College of Medicine has brought forth evidence in man and in the dog by a series of acute experiments to suggest that in normal individuals insulin and glucagon are mutually synergistic. The following observations have been made.

1) Glucagon in man and in the dog acts as a potentiator of insulin function, it being capable on intravenous administration of adding immediately and materially to the momentum of a fall in blood glucose induced by a small dose of glucagon-free insulin given by vein. Extrinsic glucagon, on the other hand, seems to be able to weight a momentum in either direction, implementing a rise or a fall, depending on which of these two phases it happens to meet (Fig. 1).

2) Glucagon seems to serve as a trigger mechanism to insulin function throughout the *postabsorptive* period, much as glucose acts as the incitor of insulin function during the *absorptive* state. Postabsorptive blood glucose is in no sense a fixed value (*4*). It is constantly oscillating throughout the entire postabsorptive period, changes taking place from moment to moment. When these are recorded at 1-minute intervals, the curves produced (Fig. 2, before "insulin I.V.") follow a characteristic pattern. We have found that the level of blood glucose is variable, and markedly so, even down to the 15-second interval (Fig. 3). The sugar has been identified as being true glucose by parallel quantitative fermentation procedure. The Somogyi-Nelson macro true-glucose method was employed in all determinations, many of which were in duplicate. Chi-square tests on aliquots of multiple single blood samples, as well as on the variations found in the curves, have shown that the findings are statistically significant and far beyond the range of error incidental to the methodology employed.

Figure 3 also shows curves drawn at 1-minute intervals, which exhibit undulations characteristic of those found in all of the 100 men and 20 dogs studied. These undulations are consistently present throughout the entire postabsorptive period. They are irregular or aperiodic in timing rather than rhythmic at any time. It might well be speculated that some of the variation, especially in the 15-second oscillations, may be related to periodic changes in blood circulation at the capillary and venous levels incidental to pulsatory phenomena. This could conceivably change the glucose content of venous blood returning from the capillary regions. Such change arising from transient capillary pooling might be expected in venous blood but not in arterial. With carefully controlled constancy of blood flow and simultaneity in blood sampling, there is consistently a lowering of the venous level precisely at the time of the rise in the arterial blood glucose. This finding would strongly suggest that these waves are more related to the supply and utilization of glucose (the gradient of entrance into cells) than to mechanics of circulation.

The descents in the postabsorptive wavelets in all probability represent changes in the gradient of entrance of glucose into peripheral cells, a well-accepted function of insulin. The glucose rises in the undulations are less easily explained. They probably represent the release of glucose from liver glycogen through activation of liver phosphorylase. Such action could take place via adrenal medullary or glucagon function, or through both, or by some mechanism as yet unexplored or unidentified. It is our opinion that the transient rises in blood glucose result from glucagon effect. This has been suggested by our studies in animals, and especially in man. It is postulated that the waves represent an interplay of the two hormones, insulin and glucagon, one activating but limiting the function of the other.

Acute dog experiments in which adrenal medullary effect was abolished by heavy ergotaminization and subsequent surgical resection of the adrenals failed materially to change the normal postabsorptive undulations, suggesting that in normal animals glucagon is capable, apart from any activity of the adrenal medulla, of producing transient releases of glucose into the blood. On the other hand, in a dog subjected to abdominal evisceration, and thus deprived of all known possible sources of glucagon and capable of only short survival, the arterial undulations disappear and are replaced by a relatively flat arterial glucose level (Fig. 4, "post-op."). The

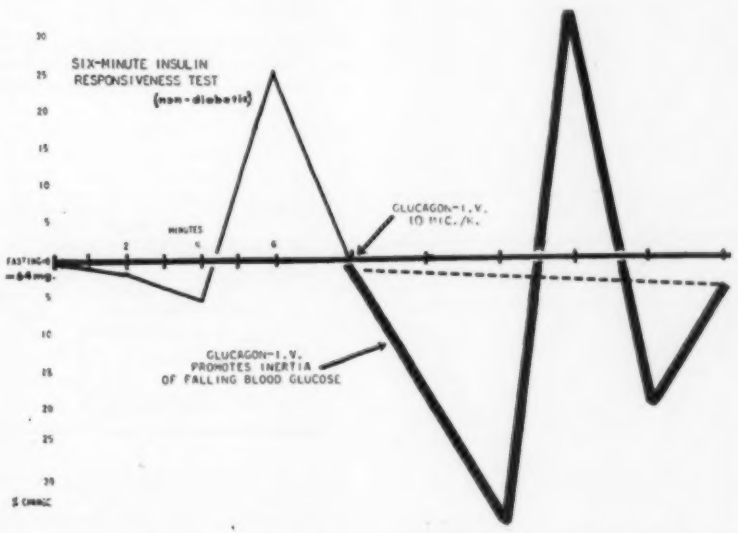


Fig. 1. Venous glucose curves in man (postabsorptive). At zero time, subject received 3 units of glucagon-free insulin—I.V. Note reinforcing of the hypoglycemic effect of insulin, a "pumping up" or crescendo of the glucose flings, which is initiated by intrinsic glucagon (the upward fling at 4 minutes) but furthered by glucagon I.V.

Dr. Anderson is a member of the faculty of the State University of New York College of Medicine at New York, N.Y.

wavelets are, however, immediately reactivated by the intravenous injection of glucagon (10 microgram per kilogram). Since the liver has been ablated, the source of the glucose for even these small increases after glucagon by vein comes up for question: Could the glucose be from peripheral sources?

Experimental work in man suggests that the transient facile spurts in blood glucose are presumably incidental to intrinsic glucagon effect, each rise seeming to "trigger" into action a short phase of insulin function. With each brief spurt of arterial glucose, there is, both in the dog and in man, a fall in venous glucose and an accompanying phase of increased arteriovenous difference (probably increased peripheral utilization) (see Fig. 2) (*3, 5*). Accordingly, glucagon would seem to be capable of promoting the peripheral utilization of glucose. Admittedly, the presence of an increased arteriovenous difference does not necessarily mean an increase of cellular utilization. Proof of such utilization must await tagged carbon studies; but, with carefully controlled circulatory constancy in animals, the simultaneous fall in venous glucose attending each arterial rise would strongly suggest tissue utilization of the glucose as the cause of the phenomenon.

3) Insulin, on the other hand, during the postabsorptive period would seem to trigger intrinsic glucagon into action. In 60 individuals with low mean fasting blood glucose levels, a small dose (1 to 3 units) of glucagon-free insulin given by vein primarily caused a prompt rise (*6–8*), rather than fall (Fig. 1) in blood glucose anticipated with insulin. In the absence of symptomatic evidence of adrenal medullary activity or of changes in the titers of lactic acid in the blood, it is likely that these rises in blood glucose were due to glucagon. In these same people, after the initial effects of the insulin had been registered, an intravenous injection of glucagon promptly caused a marked sharpening and precipitous accentuation of both the rises and the falls in blood glucose—a "pumping up" (Fig. 1) or priming effect of parenteral glucagon on the insulin effect already induced by the glucagon-free insulin. This intensification of insulin effect does not necessarily mean further production of insulin by the organism, since it occurs also in the abdominally eviscerated dog, in which the only possible available insulin is that which may still remain in the tissues after surgery. Evidently, glucagon activates and potentiates the function of insulin in tissues.

4) In the eviscerated ergotaminized dog under the influence of glucagon administered by vein, there is occasionally exhibited a venous return from an isolated extremity which is higher in its

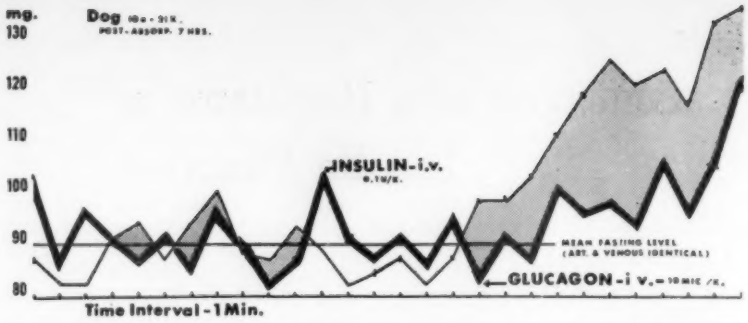


Fig. 2. One-minute macro arterial and venous blood-sugar curves in dog. Heavy line, venous; fine, arterial; shaded, a-v difference. Note the negative a-v difference immediately after glucagon-free insulin I.V. and the subsequent markedly accentuated differences after glucagon I.V.

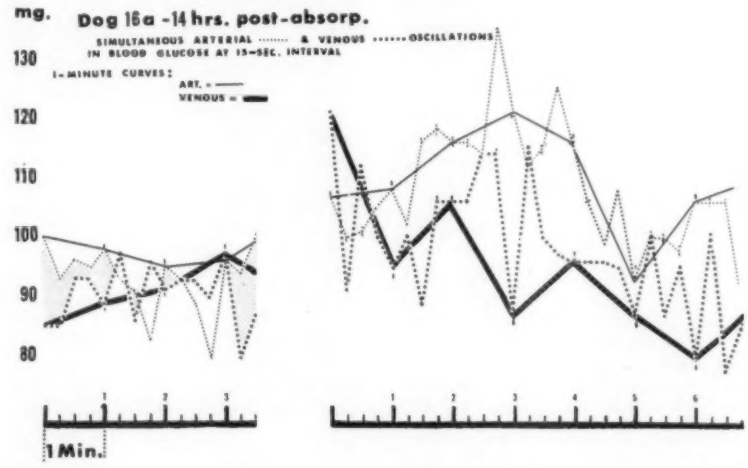


Fig. 3. In an intact normal dog, note intense excursion from reading to reading. The break in the curves represents an interval of 1 hour. A resumption of readings shows even more pronounced oscillations. The explanation for this accentuation we do not have.

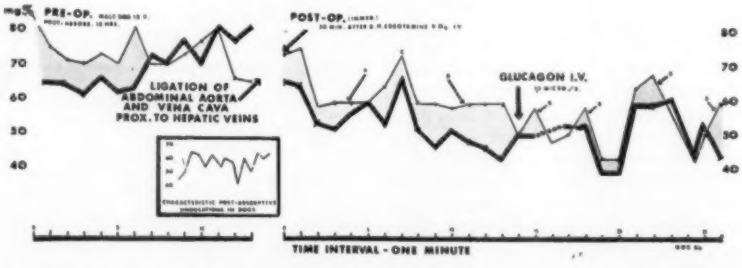


Fig. 4. Glucose curves after abdominal vascular ligations. Arterial and venous lines as in Fig. 2. Note flat level (A) over 10 readings, interrupted only once by an upward fling (probably a final effect of glucagon still residual in the peripheral circulation). Between 13 and 14 minutes, there is another drop in arterial glucose which is halted, presumably by glucagon I.V. Note prompt return of the glucagon-effected undulations. The probable source of this new glucose is peripheral tissue, since the animal has no functioning liver. This glucose rise is small, the result of depletion by extensive surgery and a long interval (18 hour) since food ingestion.

glucose content than is the arterial supply to the extremity. This finding is quite challenging since it suggests that under certain circumstances glucagon may be capable of functioning through enzyme systems other than liver phosphorylase in the release of glucose from glycogen. The phenomenon is presently being explored by studies in completely isolated extremities, the venous blood being collected in reservoirs. In addition, metabolic incubator studies are also in progress.

The seeming paradox of glucagon action, now raising and now lowering blood glucose, evidently depends precisely on which phase of the glucose wave is being exposed to the hormone. Whether the direction of the blood-glucose trend is upward or downward, the momentum of an uncompleted phase is increased or potentiated by glucagon.

The implications of the afore-described findings in clinical diabetes are legion. Is the clinical diabetic or the prediabetic individual one who has a perverted insulin-glucagon functional relationship? In these people, does insulin, intrinsic or extrinsic, in small "catalytic" dosage have the functional effect of touching off an overresponsive intrinsic glucagon mechanism at a high level of blood glucose? In similar manner, in *nondiabetic* individuals glucagon activity with its hyperglycemic effect is thrown into function by small doses of insulin only when this is administered at low mean fasting glucose levels. This finding was made in 100 nondiabetic individuals. If a perverted functional relationship exists in the diabetic suffering from a relative deficiency of insulin, the afore-mentioned concepts open up wide vistas for improving the underlying functional defect. Fortunately, in many individuals with the obese-adult type of diabetes, such apparent perversion of function is reversible by adequate therapy (*8*). This improvement is readily measurable by the so-called "six-minute responsiveness test to glucagon-free insulin," a measure of the body's ability to *respond* to insulin rather than to make it (*9*, *10*).

References

1. M. Bürger, *Z. ges. inn. Med.* **2**, 311 (1947).
2. I. J. Pincus and J. Z. Rutman, *Arch. Internal Med.* **92**, 666 (1953).
3. T. B. Van Itallie, M. C. Morgan, L. B. Dotti, *J. Clin. Endocrinol. and Metabolism* **15**, 28 (1955).
4. J. Pedersen, personal communication.
5. H. Elrick *et al.*, *J. Clin. Invest.* **34**, 932 (1955).
6. G. E. Anderson, *Diabetes* **3**, 462 (1954).
7. ———, *ibid.* **3**, 466 (1954).
8. ———, *Postgraduate Med.* **16**, 229 (1954).
9. ———, *Science*, **119**, 516 (1954).
10. ———, *Lancet* **226**, 976 (1954).

J. P. Marble, Research Geochemist

John Putnam Marble was born in Worcester, Massachusetts, 30 May 1897, and died suddenly in Washington, D.C., 6 June 1955. Since the drysaltery business was the pursuit of the family, his interest in chemistry developed at an early age. He graduated *cum laude* from Williams College in 1918 after election to Phi Beta Kappa in his junior year. He was corecipient of the John Sabin Adriance Prize in Chemistry. He entered the Chemical Warfare Service of the Army in 1918; after his discharge in early 1919, he attended Clark University as a part-time student. At the end of the school year he entered the family drysaltery business, where he continued until 1926. He then began his work at Harvard University, taking his master's degree in chemistry in 1928 and his doctorate in analytical chemistry in 1932 under G. P. Baxter.

He began, then, to find his broad interests, applying his knowledge of chemistry to the research analysis of radioactive minerals in the laboratories of the U.S. Geological Survey (1931–35) and the Smithsonian Institution (1935–55) under the auspices of the Committee for the Measurement of Geologic Time of the National Research Council. This work still occupied much of his time up to his death. During the summers through the 1930's and into the 1940's, he worked at Harvard on chemical atomic weights and devoted some time at Yale in 1939 to the preliminary preparation of thorium standards. During World War II he served as technical aide and special assistant of the National Defense Research Committee of the Office of Scientific Research and Development. His work on radioactivity and isotopes took him into close association with Alfred C. Lane, with whom he worked on the Committee on the Measurement of Geologic Time, first as a member, then as vice chairman (1936–46), and, from shortly before Lane's death, as chairman (1946–55). His work in preparing reports of the committee, with extensive critical international bibliographies, was increasingly large as the field became more and more active. The reports are a valuable addition to the literature, and the demand for them is increasing. In addition to his annual reports of the Committee on the Measurement of Geologic Time, he was the author of some 20 papers on age determinations and related subjects published in various journals, chiefly the *American Mineralogist*.

His was a work of love, and his diligence in pursuing it so actively bespeaks the character of the man and his true qualities as a scientist. There was something of a Newton and a Darwin in his perseverance and his integrity.

The work on isotopes and geologic time took Putnam more and more afield from chemistry into the realms of geochemistry and geophysics, and his boundless energy to pursue the tasks that he undertook placed many calls on him. He claimed not to like people, and yet he was always doing for people—as trustee of Sidwell Friends School, as chairman of the Committee on Meetings of the American Geophysical Union, and, for the last 2 years, as its general secretary, and in various other activities. He liked people and liked doing for them, but his Quaker background caused him to dislike the controversy and tensions that often arise from disagreements and differences of opinion. The problems involved weighed on him heavily, whether as general secretary of the American Geophysical Union, a member of the Council of the American Association for the Advancement of Science, or secretary-treasurer of the American Geological Institute. His life was truly that of a scholar who rather resented the intrusions of modern-day life caused by the rapid development of science.

He was never happier than when he was at work in his laboratory, unless it was with hammer and lens on scientific field trips, or exploring the wilds of the Adirondack Mountains, where he spent many summers.

WALDO E. SMITH

American Geophysical Union, Washington, D.C.

News of Science

Jarmo Expedition

Materials that will date the two oldest known villages in which man settled down to a permanent agricultural life have been obtained in Iraq during the last year by an expedition of the Oriental Institute of the University of Chicago. Robert J. Braidwood, professor in the institute and leader of a team of scientists in the institute's Iraq-Jarmo expedition during the past season, has returned to Chicago with a new report on Jarmo, a village he found 6 years ago between Kirkuk and Sulimaniya that has been dated about 4700 B.C. The expedition also found the even earlier village of M'leffat, which probably antedates 5000 B.C. M'leffat was found during the exploration of the basin of the Greater Zab River about 100 miles north of Jarmo.

Fifty-two carbon samples from fire pits in the villages, and from earlier cave dwellings and other sites along the Fertile Crescent were collected by the radiocarbon specialist of the expedition, Frederick R. Matson of Pennsylvania State University. The samples will be processed by the radiocarbon dating method that was developed by Willard F. Libby. It is hoped that a reliable chronology of man's early settlements in western Asia can be established. Three previous samples from Jarmo were dated by Libby in 1952 at approximately 4750 B.C. The geologist member of the team, H. E. Wright of the University of Minnesota, found evidence of Pleistocene age glaciation in the Kurdish Mountains of northeastern Iraq. Impressions of plants and grains in the mud ruins of Jarmo and M'leffat were gathered by Hans Helbaek, botanist of the Danish National Museum. Pieces of bones of animals were found in the two sites and in other prehistoric habitations by zoologist Charles A. Reed of the University of Illinois. Horn cores of goats gave one clue concerning the existence of domesticated animals about 7000 years ago.

An extensive collection of existing plants, 5000 species that were found within 4 miles of Jarmo, was made by Helbaek for comparative study with the older flora. Reed also made a complete collection of modern animals, including not only domestic, but wild species such as bear, fox, and gazelle. No wild horses or cattle exist in the region today. The last wild horse was reported in the Mesopotamia desert in 1928. Wild sheep, goats, and pigs persist; specimens of these were obtained.

Although final knowledge of conditions at the time the village existed must await analysis of the thousands of specimens collected by the expedition, the general evidence indicates that the climate and environment were not greatly different in 4500–5000 B.C. than now. Ancient Jarmo appears to have been a land of limited rain, as it is today. The original inhabitants, though fewer in number and with smaller flocks, started the process of overgrazing and deforestation that resulted in the erosion and depletion of the soil so marked today. The evidence of glaciation, together with the deduction from the various collections, may permit an informed guess concerning the climatic changes over the last 40,000 years, it is reported.

Braidwood had hoped that 3 months of excavation in the spring of this year would reveal all remaining significant features of Jarmo, but during the last week of digging, a deep trench being run through a thick concentration of ash intercepted a wall more than 5 feet thick, an architectural feature not compatible with a primitive village.

The Jarmo houses were made of unbaked mud, which is not very durable. It is Braidwood's present opinion that the 27-foot accretion on the village site, with evidence of a variety of architectural renovations, represents a period of not much more than 250 years, for the early agriculturists continually rebuilt on the heaps of their disintegrated houses.

Many small unbaked clay figurines, emphasizing pregnancy, of the "mother goddess" type, were found this year. Lesser numbers of other unbaked modeling, including some figures that were recognizable as wild boar, were also found. Bowls shaped out of marble were also found. A few shards of painted pottery were found in the upper levels. Some of the stone bowl fragments show that the grinding was planned to use the dark veins of the marble to produce decorative lines in the finished bowl.

No pottery was found at M'leffat. But there is indication that trade in obsidian existed even at that time, for the nearest source was 250 miles away in what is now Turkey. Only scattered pieces of obsidian were found at M'leffat, but obsidian exists in quantity at Jarmo, as do shells from the Persian Gulf.

Other members of the professional staff of the expedition were Bruce Howe of the Peabody Museum, Harvard University, who represented the Baghdad School of the American Schools of Oriental Research and studied the terminal cave stage of life in the area in an associated project; Vivian Broman, field assistant; and Polly Jo Anderson, University of Chicago graduate student in anthropology, anthropological assistant at Jarmo.

Survey of Graduate Students

Twenty-five percent of the resident graduate students in the United States held teaching or research assistantships or fellowships in April 1954, according to preliminary findings of a survey by the National Science Foundation. *Highlights of a Survey of Graduate Student Enrollments, Fellowships, and Assistantships, 1954* (*Scientific Manpower Bulletin*, No. 5), which was recently published by the foundation, summarizes these findings, which covered more than 152,000 resident graduate students who were enrolled for a degree in an academic department in 330 institutions of higher education.

Factual information in the bulletin includes the numbers of graduate students in the United States, their distribution by academic fields, the extent to which they obtained financial assistance in the form of teaching or research assistantships or fellowships, and the sources of funds for such financial assistance. Table 1 shows the distribution of resident graduate students enrolled for a major in April 1954 by field, and the percentages receiving these types of financial assistance.

The graduate-student population covered in the bulletin included about 94,000 first-year graduate students and 58,000 advanced students. About 47 percent of the 152,067 graduate students were attending school full time. Nearly three-fourths of the graduate students in the survey were males, and in most fields of the natural sciences the proportion of women was relatively small.

Survey findings include comparative data by field on the number of graduate students who held teaching or research assistantships or fellowships and the dollar amounts of the stipends paid. Although those who received financial assistance represented about one-fourth of the total number of graduate students concerning whom information was obtained, the proportion who received stipends varied widely from one field to another. Within the natural sciences, for

Table 1. Distribution of resident graduate students by field

Field	All graduate students	Percentage with assistantships or fellowships
All fields	152,067	24.7
Life sciences	11,930	65.7
Physical sciences .	19,009	58.8
Engineering	14,249	25.2
Psychology	5,444	31.6
Social sciences ..	15,405	24.1
Humanities and arts	9,289	32.2
Health professions	1,323	39.9
Education	51,053	3.6
Other professional fields	24,365	17.4

example, about two-thirds of the graduate students were receiving some type of support, whereas in mathematics only 42 percent of the graduate students were receiving financial assistance. Nearly 70 percent of the graduate students in chemistry and about 60 percent of those in physics held assistantships or fellowships.

The median dollar amount of the stipends received by graduate students holding teaching or research assistantships or fellowships showed important differences among academic fields. In general, the stipend levels for students in education and the humanities and arts tended to be relatively low, whereas stipends in the natural sciences, engineering, and the health professions were considerably above the averages for all fields.

Not only did the survey show variations in the amounts for stipends paid in different academic fields, but also it showed wide variation in median stipends for teaching and research assistants and for fellowship holders in the same field. For example, graduate students majoring in physics and holding teaching assistantships received a median stipend of $1260; those with research assistantships received $1550; institutional fellows (university funds) received $1093; and noninstitutional fellowship holders received $1580.

Limited numbers of copies of this bulletin are available to readers who are interested in more detailed information on findings for the major fields of study or on the scope of the survey. Requests should be addressed to National Science Foundation, Washington 25, D.C.

News Briefs

■ Nearly 150 scientists from 32 nations who had attended the Geneva conference on the peaceful uses of atomic energy flew to England on 24 Aug. to spend the day in Britain's atomic research establishment at Harwell. The Soviet Union, other East European countries, and Communist China were represented in the group, which was welcomed by John Cockcroft, director of Harwell.

The visitors were told of Harwell's work in the development of prototypes and designs of nuclear reactors, some of which will soon provide England with electricity. Eighteen exhibitions of workshops were thrown open to the group, with technical experts at hand to explain details.

The models at Harwell, built for research and to examine the possibilities of extracting power commercially from the atom, are also used to produce radioisotopes for industry and medicine. In another section of the center, scientists were shown how these isotopes are withdrawn from the heart of the atomic pile and shipped for processing to chemical laboratories elsewhere in the country for issue to hospitals and factories.

D. V. Skobeltzin, a Soviet delegate to the Geneva conference, has invited Cockcroft to visit nuclear power installations in the U.S.S.R. The trip is being arranged at a time that is mutually convenient. The exact locations of the Soviet nuclear plants were disclosed for the first time during the last session at Geneva: reactors at Moscow and Leningrad, cyclotrons at Kiev and Leningrad, a linear accelerator at Kharkov, and a synchrotron at Moscow.

■ Using rockets vertically launched from aircraft, personnel of the Office of Naval Research have demonstrated the feasibility of another method of upper atmosphere research. In recent tests at the Naval Air Station, Chincoteague, Va., rockets launched vertically from a Navy Banshee fighter plane at 30,000 feet reached an altitude of approximately 90,000 feet. It is hoped that the new rocket-aircraft method, called "rockair," will afford a practical and inexpensive tool for research observations at high altitudes.

Rockets launched from planes do not attain the altitudes reached by large rockets; however, it is felt that there are many possible applications of the new plane-rocket method. The system is expected to stimulate intensified research in the upper atmosphere by permitting reseach opportunities for synoptic measurements not heretofore feasible because of cost. The method will be used to obtain measurements of ambient air temperatures, air densities, ozone concentrations, and high-altitude winds. Its use to obtain synoptic measurements over a broad geographic area during the forthcoming Geophysical Year has been considered.

The Navy has been using balloons for high-atmosphere research since 1947, when its Skyhook program was developed. Another technique, "rockoon," which utilizes the Skyhook balloon to carry Deacon meteorological rockets aloft, has been used for studies in the auroral regions. The feasibility of this low-cost method has been demonstrated in the annual summer expeditions in northern waters. The small Deacon rockets are fired from the balloon at an altitude of 70,000 feet, above the drag of the earth's atmosphere.

The chief advantage of the new plane-rocket method over the balloon-rocket technique is the controlled-directional launching possible from aircraft. The new rockets, smaller than the Deacon rockets, were provided by the Navy Bureau of Ordnance. The Bureau of Aeronautics, which sponsored the project, assisted ONR by supplying both technical aid and personnel. The vertically launched rockets are to be used in the immediate future for upper air wind research.

■ A group of Italian scientists intends to create within the next 2 or 3 years an artificial aurora borealis that will reproduce in temperate climates the phenomenon as it is observed in the arctic. The aurora will be created by radio waves transmitted into the ionosphere.

This artificial aurora borealis will be an Italian contribution to the International Geophysical Year. Announcement of the plan was made by the Italian delegation to the international congress on the ionosphere that took place recently in Venice, Italy.

■ A second nuclear research reactor for West Germany is to be built in Munich. It will be placed under the direction of Werner Heisenberg, director of the Max Planck-Institute for Physics, Göttingen.

■ Oceanographers have been reporting so many new peaks, ridges, basins, seamounts, and other underwater landmarks that naming them all has become a major problem. Therefore, the British National Committee on the Nomenclature of Ocean Bottom Features has issued a list of 15 rules to guide the deep-sea investigators in naming their finds in a systematic manner. John D. H. Wiseman and Cameron D. Ovey have described the committee's recommendations in a recent issue of the journal, *Deep-Sea Research*.

■ A map showing where the earth's 44,000 daily thunderstorms occur is being completed by the United Nations Meteorological Organization. A report on thunderstorms states that the average one releases 50 times the energy of the first atomic bomb. Also during an average thunderstorm 110,000 tons of water pour upon an area of 8 square miles;

however, only one in nine potential raindrops actually reaches the ground. The UN map will not include Antarctica, the only continent where there are no thunderstorms.

Scientists in the News

CHARLES E. KELLOGG, since 1934 head of the Soil Survey, U.S. Department of Agriculture Soil Conservation Service, was presented an award for distinguished service on 19 Aug. during the Michigan State University centennial celebration. The citation from his alma mater read: "Throughout your long and distinguished career as a soil scientist you have labored effectively to benefit mankind the world over by furthering the knowledge and use of the soil."

The State Department has announced that it will sponsor lectures in European and Near East countries by the members of the United States delegation to the Geneva atomic-energy conference. The scientists and the places where they will lecture are as follows.

CLIFFORD BECK, head of the physics department and specialist on nuclear reactors at North Carolina State College—Athens.

AUSTIN BRUES, director of biological and medical research at the Argonne National Laboratory—Brussels, Belgium, Copenhagen, Denmark, and London.

WINSTON MANNING, director of the chemical division at Argonne National Laboratory—Brussels.

FRANK SPEDDING, director of the Institute of Atomic Research and of Ames Laboratory of the Atomic Energy Commission—Stockholm, Sweden, Paris, and Copenhagen.

KARL MAYER, economic adviser on the staff of the general manager of the Atomic Energy Commission—Brussels.

LEE FAIR, director of the department of medical research at Brookhaven National Laboratory—Athens, Cairo, Copenhagen, and Ankara, Turkey.

JOHN SWARTHOUT, director of the chemical division in Oak Ridge National Laboratory—Germany.

WALTER ZINN, director of the Argonne National Laboratory—Britain and Italy.

ULYSSES M. STEEDLER, chief of the Civilian Reactors Branch of the Atomic Energy Commission—Cairo.

DONALD HUGHES, physicist at Brookhaven National Laboratory—Britain.

RALPH OVERMAN, director of the Oak Ridge Institute of Nuclear Studies—Cairo (for 1 month).

H. ARNOLD KARO was appointed by President Eisenhower as director of the Coast and Geodetic Survey, U.S. Department of Commerce, on 12 Aug.

The following appointments to assistant professor have been announced. University of Tennessee College of Medicine: EDWARD H. STORER, surgery. Northwestern University: LASZLO LORAND, biochemistry. In mathematics: Boston College, EVELYN M. BENDER; Purdue University, W. H. FLEMING; Washington University (St. Louis, Mo.), J. K. GOLDHABER; University of California (Santa Barbara College, Goleta, Calif.), R. T. GREGORY; University of Alabama, J. L. HOWELL; University of Kentucky, FRANK LEVIN; Georgetown University, ANNE E. SCHEERER; Montana State College, W. J. SWARTZ; Long Beach State College, F. R. YETT; University of Illinois, J. A. ZILBER.

The International Astronomical Union held its 9th general assembly at Dublin, Ireland, 2 Aug.–5 Sept. The United States Government was represented by the following delegation: J. J. NASSAU, director of the Warner and Swasey Observatory of Case Institute of Technology and chairman of the U.S. National Committee of the IAU; I. S. BOWEN, director of Mount Wilson and Palomar Mountain Observatories, Pasadena, Calif.; G. M. CLEMENCE, director of the Nautical Almanac Office, U.S. Naval Observatory, Washington, D.C.; G. P. KUIPER, professor of astronomy, Yerkes Observatory of the University of Chicago, Williams Bay, Wis.; ROBERT R. MCMATH, director of the McMath-Hulbert Observatory, University of Michigan; OTTO STRUVE, professor of astronomy, University of California, Berkeley, and president of the IAU; F. L. WHIPPLE, professor of astronomy, Harvard College Observatory, Cambridge, Mass.; and A. E. WHITFORD, director of the Washburn Observatory of the University of Wisconsin.

ALFRED J. STAMM, a specialist in wood chemistry at the U.S. Forest Products Laboratory, Madison, Wis., arrived in Australia on 22 Aug. He will spend 9 months working with the Commonwealth Scientific and Industrial Research Organization's Division of Forest Products as a senior Fulbright fellow.

He plans to study wood fibers, with particular reference to their use in paper making. Stamm has previously studied the bonding between fibers in paper by electric methods; while he is in Australia he expects to extend this work by means of optical techniques.

DOUGLAS H. K. LEE, professor of physiological climatology at Johns Hopkins University, was appointed chief of the research branch, Research and Development Division, Office of the Quartermaster General, Washington, D.C., on 1 Sept.

LEWIS ELDRED, former president of Elmira College, has been named manager of personnel and administration for the electron physics department at the General Electric Research Laboratory, Schenectady, N.Y. Eldred served as professor of mathematics at Elmira before he was named president in 1949.

HERMAN N. EISEN, associate professor of industrial medicine at New York University Post-Graduate Medical School, has been named head, effective 1 Oct., of the new dermatology division at Washington University School of Medicine, St. Louis, Mo. The division, which is the first of its kind in a privately endowed university, is being established with the aid of a $400,000 Rockefeller Foundation grant that was announced last December.

S. D. S. SPRAGG, professor of psychology at the University of Rochester, has received a Fulbright award that will permit him to spend the coming year at the Technische Universität, Berlin-Charlottenburg, Germany. He will lecture on experimental psychology and human engineering.

The following mathematicians have received new appointments.

C. M. ABLOW of the Boeing Airplane Co., Seattle, Wash., has accepted a position as senior research mathematician with the Standard Research Institute.

R. R. BERNARD of Yale University has been appointed associate professor at Davidson College, Davidson, N. C.

RENÉ DEHEUVELS of the Institute for Advanced Study, Princeton, N.J., has been appointed professor at the University of Lille, France.

D. O. ELLIS, professor at the University of Florida, has accepted a position as associate mathematician with the Rand Corp., Santa Monica, Calif.

S. T. HU of Tulane University has been appointed professor at the University of Georgia.

MARK KAC, professor of mathematics at Cornell University, will be on leave during the coming academic year. With the support of an Air Force contract he plans to conduct research in Geneva, Switzerland.

W. G. MADOW of the University of Illinois has been appointed visiting professor of statistics at Stanford University.

W. E. MILNE, professor at Oregon State College, retired on 1 July.

PAUL OLUM, associate professor at Cornell University, will be on leave to work at the Institute for Advanced Study.

HENRY PARKUS of Michigan State College has been appointed to a professorship at the University of Technology, Vienna, Austria.

J. F. RANDOLPH of the University of

Rochester will be on leave during the coming academic year to serve as a visiting professor at American University, Beirut, Lebanon.

WLADIMIR SEIDEL of the University of Rochester has been appointed to a professorship at the University of Notre Dame.

R. C. T. SMITH of the University of New England, Armidale, Australia, has been appointed a visiting lecturer at Massachusetts Institute of Technology.

W. S. SNYDER of the University of Tennessee has been appointed to the staff of the Oak Ridge National Laboratory, Oak Ridge, Tenn.

KURT STREBEL of the Institute for Advanced Study has been appointed professor at the Université de Fribourg, Switzerland.

LOUIS G. DUNN has been promoted from associate director to director of the guided missile research division of the Ramo-Wooldridge Corp., Los Angeles, Calif.

CORBIN ALLARDICE has left his post as executive director of the Joint Committee on Atomic Energy to accept the newly created position of atomic energy adviser to the International Bank for Reconstruction and Development, Washington, D.C.

Necrology

CHARLES C. ADAMS, Albany, N.Y., 81, ecologist, former director of New York State Museum, one of the founders and a past president of the Ecological Society of America, and a AAAS member for 54 years, 22 May.

CHARLES P. BERKEY, Palisade, N.J., 88, geologist and water supply expert, former head of the department of geology at Columbia University, and a AAAS member for 54 years, 22 Aug.

ROBERT B. CAMPBELL, Fort Myers, Fla., 63, geologist consultant in western Canada and Florida, 16 Aug.

CHARLES A. DICKENS, Fort Lauderdale, Fla., 76, former professor of psychology at the University of Maine, 23 Aug.

HORACE EDWIN HAYDEN, New York, N.Y., 71, biologist, and bibliographer and editor for New York University, the New York Public Library, and Charles Scribner's Sons, 22 Aug.

(CARL) LELAND HORBERG, Chicago, Ill., 45, associate professor of geology, University of Chicago, editor of the *Journal of Geology*, former president of the Association of Geology Teachers, and secretary of AAAS Section E—Geology and Geography, 1949–52, 18 Aug.

J. ALBERT KEY, Wesco, Mo., orthopedic surgeon and professor emeritus of clinical orthopedic surgery at Washington University School of Medicine, 6 Aug.

CARL D. LA RUE, Ann Arbor, Mich., 67, botanist and researcher at the University of Michigan, 19 Aug.

EDUARD PERNKOPF, Baltimore, Md., 67, anatomist, professor emeritus of the University of Vienna and director of the Institute of Systematic Anatomy, 17 Apr.

Education

■ The University of Pennsylvania has announced that its Edgar Fahs Smith Memorial Collection in the History of Chemistry has been reopened for service in new quarters in the Hare Building, 36 and Spruce Sts., Philadelphia. Originally consisting of some 7000 items, the collection has grown to include more than 9000 books and pamphlets, nearly 1400 manuscripts, 3400 portrait prints and medals of chemists, and various items of chemical apparatus. Acting curator of this collection, which is one of the largest of its kind in the United States, is Claude K. Deischer, assistant director of the university's Harrison Laboratory of Chemistry.

■ Plans for the establishment of a pilot Cardiovascular Training Center for Nurses have been announced by the U.S. Public Health Service. The first of its kind, the center will be located at the University of Minnesota School of Public Health, starting 1 Jan. 1956. Cooperating with the Public Health Service in the project are the Minnesota Department of Health and other agencies in Minneapolis and St. Paul.

Nurses for the first group to train at the center will be drawn chiefly from consultant, supervisory, and instructor positions. Candidates will represent the various fields of nursing—hospital, industrial, education, and public health. Applications for the training center are being received at the University of Minnesota School of Public Health. Early applications are urged since the first group will be limited; studies are scheduled for one quarter.

Grants, Fellowships, and Awards

■ Two Frank L. Chance research fellowships, one in hematology and one in medical oncology, are to be awarded by the City of Hope Medical Center. Inquiries should be directed to Dr. Howard Bierman, City of Hope Medical Center, Duarte, Calif. *The deadline date is 1 Oct.* These fellowships were established by the late Mrs. Frank L. Chance in honor of her husband, the Chicago Cubs baseball player who was a member of the double-play team, Tinker-to-Evers-to-Chance.

Five fellowships are available each year for periods of from 1 to 3 years. Fellows selected hold an appointment in the center's Medical Research Institute, with a dual title in one of the center's hospitals if the research to be conducted is of a clinical nature. The annual stipend varies from $3000 to $5000, depending upon the previous training of the candidate.

The fellowships were designed to afford special training in the fields in which the City of Hope Medical Center is engaged. These are (i) tumors and allied diseases; (ii) hematology; (iii) cardiac disease amenable to surgery; and (iv) cardiorespiratory diseases.

■ American Cancer Society clinical fellowships in radiation therapy are offered in 1956–57 to properly qualified graduates in medicine who have already received thorough basic training in the principles and practice of radiation therapy, and who desire to spend additional periods of training in that specialty at certain clinics in the United Kingdom, the Scandinavian countries, and France. Fellowships are available to citizens of the United States who are graduates of recognized medical schools in the United States, who have previously received training in the therapeutic radiology acceptable to the American Board of Radiology as credit toward certification, and who are under 40 years of age. In the selection of applicants, priority will be given to physicians who are already certified by the American Board of Radiology, and who have completed the required training in preparation for board examinations but who have not yet taken the examinations, and those who are still in the training period but who intend to complete board requirements and take the examinations.

The annual stipend is $4500 per year, including travel. When a fellowship is awarded, an initial travel fund of $900 will be paid to the recipient. The remainder of the stipend will be paid in advance in monthly installments of $300, beginning with the fellowship period.

The fellowship period shall be 1 year, although in exceptional circumstances, and when there is no competition with new applications, renewal for a year or less will be considered. Fellowships may commence at any time mutually agreeable to the institution and the fellow.

Fellows may choose to spend the entire fellowship year in one institution or to divide the time between two or more; in the latter case, however, at least 8 months must be served in a single institution in order that a reasonable measure of practical experience, rather than observation only, may be assured.

All arrangements for affiliation with foreign institutions in which the fellowship year is to be passed are to be made by the fellow or his preceptor directly with the appropriate officials in those institutions, and the American Cancer Society will assume no responsibility therefor. Such arrangements will be made after the fellowship is awarded, and only the contemplated program need be submitted with the application. Candidates must file three letters of recommendation with their application. Further information and application forms may be obtained from the American Cancer Society, Inc., Professional Education Section, 521 W. 57 St., New York 19.

In the Laboratories

■ The Sun Oil Co. has organized a new applied physics section in order to keep pace with advances in petroleum refining technology and the growing use of radioactive tracers, electronic computers, and data logging devices. This new section is part of the engineering division of Sun's manufacturing department and is located at Newtown Square, Pa. E. Neil Shawhan has been appointed manager of the section, and Einar T. Young has been named assistant manager.

■ Dedication last month of a new $5-million Metals and Ceramics Building at the General Electric Research Laboratory, Schenectady, N.Y., concluded a week-long program of conferences and seminars attended by some of the nation's leading scientists, professors of metallurgy and ceramics, and representatives of the G.E. operating components to be served by the new laboratory facility. Principal speaker at the dedication ceremony was Donald A. Quarles, Secretary of the Air Force.

Completion of the structure is part of the $13-million expansion program for the research laboratory that was announced last year. The objectives of the new laboratory are (i) to ascertain and analyze the areas of most critical need for materials and processes; (ii) to develop new processes for new businesses; (iii) to develop new materials to improve products; (iv) to study existing materials and obtain a better understanding of their properties and processing; and (v) to operate pilot plants and obtain economic data.

The establishment of the Metals and Ceramics Building includes the organization of a group of scientists to seek out and solve problems pertaining to materials and processes wherever they may appear in the company. Thus, amid facilities of both laboratory and industry size, the findings of G.E.'s metallurgists, ceramists, physicists, and chemists can be applied to the kinds of problems that are now faced at the designer's level.

Miscellaneous

■ A limited supply of radioactive Δ^4-androsten-11β-ol-3,17-dione and 21-desoxyhydrocortisone is now available to qualified investigators, free of charge, through funds supplied by the U.S. Public Health Service's National Institute of Arthritis and Metabolic Diseases. Both substances are labeled at position 4 with carbon-14. The first compound has a specific activity of 1.47 millicuries per millimole, and the second has a specific activity of 0.095 millicuries per millimole.

Both compounds were prepared by Harold Levy and Stanley Kushinsky of the Worcester Foundation for Experimental Biology. The first was biosynthesized from 4-C^{14} progesterone; the second was made by chemical conversion from 4-C^{14} hydrocortisone.

This announcement represents another step in the institute's program to provide materials for advancing the knowledge of endocrinology, particularly the mode of action of hormones. In 1953 NIH announced the availability of ring-labeled, radioactive cortisone and hydrocortisone, which have been used by approximately 50 laboratories throughout the world in metabolism studies of these hormones. Both of these tagged compounds, as well as several intermediates, may still be obtained in small quantities.

Requests, in the form of a letter concisely describing the proposed research, may be sent to the Endocrinology Study Section, Division of Research Grants, National Institutes of Health, Bethesda 14, Md. Transfer and use of these materials is subject to current Atomic Energy Commission regulations.

■ The Department of Commerce has undertaken, through a cooperative arrangement with the Atomic Energy Commission, to make public as promptly as possible nonclassified AEC research reports of industrial significance. As the first action of this program, on 22 Aug. 961 of the most important reports selected from the AEC accumulation of research were made available through Commerce's Office of Technical Services. About a third of these reports have had limited circulation in the past, but most of them have not been previously published.

These reports cover many areas of scientific and industrial interest, including chemistry, geology, metallurgy, mineralogy, ceramics, instrumentation, physics, and reactor technology. They range from general studies such as *Fission Products Utilization* to such titles as *Radiation Stability of Plastics and Elastomers, Surface Preparation of Zirconium for Brazing,* and *The Titanium-Vanadium System.*

The AEC will turn over to Commerce on a continuing basis reports of new research as well as additional reports of earlier research as they are released.

The 961 reports are identified in a *List of AEC Research Reports for Sale,* which may be obtained free from the Office of Technical Services. Reports released in the future will be abstracted in OTS's monthly publication *U.S. Government Research Reports,* available at $6 a year from the Superintendent of Documents, Government Printing Office. They will also be listed in subsequent *Lists of AEC Research Reports for Sale,* which will be published twice a year.

■ Competitive examinations for appointment of physical therapists as commissioned officers in the regular corps of the U.S. Public Health Service will be given at central points throughout the country on 15, 16, and 17 Nov. Candidates will be examined at the centers nearest their homes. *Applications close 15 Oct.* Entrance pay for the positions available ranges from $4268 to $6017 per annum.

Further information can be obtained from the Division of Personnel, U.S. Public Health Service, Department of Health, Education, and Welfare, Washington 25, D.C. Applicants will be notified where to go for examinations.

■ The American Dental Association has announced plans for a new journal, *Dental Abstracts.* The first issue is scheduled for January 1956.

Dental Abstracts will contain summaries of articles drawn from all the important dental publications in the world. In addition to material from English-language journals, a single issue may include translated material from articles originally printed in German, French, Swedish, Italian, Spanish, or several other languages, according to Lon W. Morrey of Chicago, Ill., ADA editor.

The new publication has a dual purpose: (i) to provide a brief monthly survey of dental progress throughout the world; (ii) to give readers enough information about an article to enable them to determine whether or not they need to read the original in its entirety. A charter subscription may now be obtained by mailing a check for $6 to the American Dental Association, Subscription Department, 222 E. Superior St., Chicago 11, Ill.

Reports and Letters

Study of Tumor Cell Populations by Monte Carlo Methods

A method for calculating the growth of cell populations has been developed with the aid of the Los Alamos digital computer known as the MANIAC (*1*). One of the major obstacles to the estimation of the growth of a cell population, such as occurs in transplantable mouse tumors, has been the randomness in the intermitotic time. The chain reaction arising from binary fission of cells is very sensitive to the intermitotic time.

The digital computer is given a probability distribution for the intermitotic times and, by the Monte Carlo method, grows the hypothetical population, or "tumor," beginning with one cell. As this cell grows, the machine plays the game of chance determining when division occurs, the rules of the game being given by the probability distribution. At the instant that division starts a probability distribution of mitotic durations takes over, and another game of chance is played to specify when the division is complete. The cycle is repeated for all daughter cells until the allotted time interval has elapsed. This is a free birth process. Cells live independently; none die; and the population increases exponentially with time.

Population growth is followed by having the computer print out at prescribed time intervals the number of cells in mitosis and those intermitotic, the number of cells having different intermitotic ages, and the number of cells in the different stages of mitosis.

Three major distributions of the intermitotic times have been explored, each representing widely different models of cell growth. The first model was the analogy with radioactive decay that has been applied by Iversen and Arley (*2*) to chemically induced tumor growth in mice. The cell has a finite probability of dividing as soon as it is formed, and thereafter the probability that it has not divided decreases exponentially. The second model was designed to avoid the possibility of having a cell divide immediately upon birth. The first model based on radioactive decay was modified by introducing a rest period after birth. Following the "rest" period there is a finite probability of dividing, which also decays exponentially. The third model was based on the spread of intermitotic times measured by direct observation of mouse spleen cells in tissue cultures by Fell and Hughes (*3*). Their data show a spread of a factor of 2. Although they are too scant to describe a complete probability distribution, they provide an estimate on which to construct a tentative model.

A notable result of the computations is the long time required for the cell populations to reach a steady growth. In all three models tumors of 50,000 cells each were grown to establish the average cell generation times and the mitotic index. Wide fluctuations reflecting the random incidence of division about the average occurred during the first nine average generation times. A cell and its two daughters may take long times before dividing. Although two generations have divided, they may have taken as much as five average generation times to do so. This means that there is a fundamental latent period of growth when one cell starts out in a random growth cycle.

The effect of the randomness is that the growth curve of the population stemming from one cell does not necessarily extrapolate back to one cell at zero time. Statistically, single cells generate widely differing numbers of cells in a fixed time interval. In the first model of growth six single cells grew populations ranging from 41 to 2300 cells in an interval of nine average generation times. In the third model, based on mouse spleen cell data, fluctuations of 30 percent appeared in the time required to generate 1000 cells along with variations in the mitotic index up to 4 times the average.

The computed incidence of mitosis is found to follow a Poisson distribution, which has been reported in experimental data on mouse ear skin and on mouse tumors. An unexpected finding in the computations was that the average mitotic index in freely growing cell populations is not always simply related to the time parameters of the life-cycle. When a rest period, during which no division can occur, is introduced into the early life of the cell, the mitotic index is less than that based on the ratio of the average duration time to the average generation time. This means that even in the exponential growth of independent cells as carried out on the computer, the mitotic index is a complex function of the cell's time parameters.

The sizes of the cell populations generated in the random birth process are sensitive to the distribution of intermitotic times. If the latter has a narrow range of possible values, then the "tumors" grown by the computer fall within narrow limits. In the obvious case where cells have but one possible intermitotic time they multiply with a clocklike regularity and always produce the same sized tumor in a given time interval.

At the other extreme wherein the intermitotic time scatters by a factor of 5, the tumors grown in a fixed interval vary by a factor of 56 in size. The sensitivity between tumor sizes and the intermitotic times should provide a method for determining the latter from experimental data on the former, especially with single-cell inoculations, since the computer can indicate the expected tumor sizes in idealized models of growth.

The Monte Carlo method affords a means of bridging the gap between cell sizes and time parameters in a cell's life. This hinges on the fact that the age structure of the population determines the distribution of sizes, both of cells and of nuclei. Thus in the mouse tumors nuclei and the entire cell may grow exponentially (*4*) with intermitotic age. Therefore the volume distribution of nuclei permits inferences about the distribution of intermitotic times by the computer method.

Of fundamental interest are the events that cause randomness in a cell's growth period. The method makes possible estimates concerning the sequence of events in that period. The model based on radioactive decay is basically one in which a single random event sets off the division process. Our second model merely introduced a rest period before this single event was allowed. The third model had inherent a mechanism of about 20 random events that had to occur in a time sequence before division could be started.

Such events may be speculatively associated with chromosomes or large groups of molecules in growth. During the intermitotic growth a cell must undergo a characteristic series of operations. Kendall (*5*) analyzed the data on *B. aerogenes* of Kelly and Rahn and estimated that 20 discrete events occur before division. Rahn's (*6*) original hypothesis about this bacterium was that simultaneous submicroscopic processes, whose number was identified with the gene number, took place. In the Dba mouse tumor grown subcutaneously there appear to be 18 random events in sequence

that determine cell division. The meaning of these numbers has yet to be clarified. But the Monte Carlo method affords a means for estimating them from data on various aspects of individual cell life.

JOSEPH G. HOFFMAN
Biophysics Division, Rosewell Park Memorial Institute, Buffalo, New York
NICHOLAS METROPOLIS
VERNA GARDINER
Theoretical Division, Los Alamos Scientific Laboratory, Los Alamos, New Mexico

References and Notes

1. This work is supported by the U.S. Atomic Energy Commission.
2. S. Iversen and N. Arley, *Acta Pathol. Microbiol. Scand.* **27**, 1 (1950).
3. H. B. Fell and A. F. Hughes, *Quart. J. Microscop. Sci.* **90**, 355 (1949).
4. J. G. Hoffman, *The Size and Growth of Tissue Cells* (Thomas, Springfield, Ill., 1953).
5. D. G. Kendall, *J. Royal Statist. Soc.* **B14**, 41 (1952).
6. O. Rahn, *J. Gen. Physiol.* **15**, 257 (1932).

7 January 1955

Nonbicarbonate Buffers in Cell Culture Media

The use of cell cultures in studying fundamental problems in many fields of experimental biology has increased considerably in the last few years. It is frequently desirable to employ cells that have been cultivated under conditions that are as standardized as possible. From the beginning of "tissue culture," cells of mammalian and avian origin have been cultivated *in vitro* in media composed of a balanced salt solution containing sodium bicarbonate as the principal buffer, supplemented with embryo extract and serum. Adequate control of the *p*H of such cultures introduces a number of technical problems, for it is necessary to maintain a specified carbon dioxide tension in the atmosphere by employing gassing procedures and closed culture flasks. In an attempt to circumvent some of these difficulties, studies were initiated to test the possibility of growing cells in media containing a fixed buffer instead of the conventional bicarbonate system. In addition to facilitating the control of *p*H and reducing the labor required for maintaining cultures, fixed-buffer media have a number of obvious applications in mass culture techniques and in metabolic and viral studies with cultured cells.

The following cell cultures were employed: fibroblasts derived from normal human foreskin, testicle, human embryonic kidney, and lung, as previously described (*1*); epithelial cells, strain HeLa (*2*); mouse fibroblasts, strain L (*3*). All cultures were grown directly on glass. The medium for foreskin, embryonic kidney, lung, and testicle cells consisted of mixture No. 703 (*4*) supplemented with 5-percent beef embryo extract and 10- to 20-percent horse serum. Human serum (20 percent) was employed instead of horse serum for HeLa cultures, and the L cells were grown on mixture No. 703 supplemented with 10-percent beef embryo extract.

The sodium bicarbonate of mixture No. 703 was replaced with tris(hydroxymethyl)aminomethane (5, tris) at concentrations of 2.0 to 3.6 g/lit, and the *p*H was adjusted to the desired value by the addition of hydrochloric acid. This mixture was supplemented with embryo extract and serum in the same concentrations as were employed for the stock cultures. Foreskin, embryonic kidney, lung, and testicle cultures grew as well as the controls (bicarbonate medium) with all levels of tris when the initial *p*H of the nutrient fluid is 7.8 to 8.1. All cultures were propagated serially with weekly subcultures. Foreskin and testicle cells have been maintained for the longest period and continue to do well after 3 mo. These cultures have been maintained in both stoppered flasks and in flasks closed only by means of cotton plugs or loose-fitting metal caps. A number of differences between cells grown in tris and those grown in bicarbonate have been observed. For example, it appears that the number of cells required per flask is a more critical factor in tris fluids than it is in bicarbonate fluids. The only change in the appearance of cells cultured in tris fluids noted to date is a small increase in the number of intracellular granules. The results of a limited number of experiments indicate that prolonged cultivation of cells in fluids containing tris does not alter their susceptibility to infection with polio virus or the yield of virus. In contrast with the growth rate of normal human fibroblasts, the growth rate of HeLa and L cells was somewhat inhibited with higher levels of tris. The HeLa cells were smaller and more granular than those in the control cultures and there was a tendency for the cells to grow in clumps rather than as a continuous monolayer. The L cells also exhibited changes in morphology when they were cultured in media containing tris. Despite alterations in morphology and decreased rate of proliferation, both strains have been maintained through 14 subcultures and continue to proliferate at a constant rate.

The results of short-term experiments indicate that glycylglycine is less toxic than tris for HeLa cultures. Under these conditions, the cells grew rapidly without any appreciable alteration in morphology. Cultures of foreskin cells, however, did not proliferate as well in glycylglycine as they did when tris was employed as the principal buffer.

Although the results obtained to date with tris are particularly promising with cultures of normal human fibroblasts, factors such as concentrations of tris, optimal *p*H, and the effect of other constituents of the medium require more detailed study before a final evaluation can be made. Several organic and inorganic compounds with a pK_a in the range of 6.5 to 8.5 that are compatible with other components of cell culture media are now under investigation in an attempt to replace tris in cultures where it is toxic or where the optimal *p*H for growth is below the effective limit of this buffer system.

H. E. SWIM
R. F. PARKER*
Department of Microbiology, School of Medicine, Western Reserve University, Cleveland, Ohio

References and Notes

1. H. E. Swim and R. F. Parker, *Proc. Soc. Exptl. Biol. Med.* **83**, 577 (1953).
2. G. O. Gey, W. D. Coffman, M. T. Kubicek, *Cancer Research* **12**, 264 (1952).
3. K. K. Sanford, W. R. Earle, G. D. Likely, *J. Natl. Cancer Inst.* **9**, 229 (1948).
4. G. M. Healy, D. C. Fisher, R. C. Parker, *Can. J. Biochem. Physiol.* **32**, 327 (1954).
5. G. Gomori, *Proc. Soc. Exptl. Biol. Med.* **62**, 33 (1946).

* Aided by a grant from The National Foundation for Infantile Paralysis.

9 May 1955

Substrate Specificity of Peroxidase

A current view of enzyme specificity is that compounds of certain specific configurations can be bound by the enzyme and can lead to formation of the activated complex. The substrate specificity of catalases and peroxidases for hydrogen peroxide has been recognized for some time, and Theorell has recently suggested the term *hydroperoxidases* for this class of enzymes (*1*).

Such a definition of specificity includes reactions with homologs of the substrate, methyl or ethyl hydrogen peroxide, which have been shown to react in a second-order fashion with peroxidase and to form the same series of intermediates as does hydrogen peroxide (*2*). But the possibility of forming these reactive intermediates by a wide variety of inorganic oxidizing agents, recently pointed out by P. George (*3*), would seem to vitiate current ideas of formation of the enzyme-substrate compound and to favor the idea that the spectroscopically detectable peroxidase intermediate (complex I) is only the product of some rapid, unobserved oxidation reaction caused by a great variety of nonspecific oxidants.

This possibility lead George to the view that peroxide would react by a similar mechanism and would not therefore be a component of the structure of complex I, nor would it, per se, be required for

Table 1. Effect of bromoiridate concentration on the rate of disappearance of bromoiridate and the rate of appearance of complex I (0.01M borate buffer at pH 9.18).

Expt.	Bromoiridate (μM)	Peroxidase (μM)	Rate of disappearance of bromoiridate* (sec^{-1})	Rate of formation of complex I* (sec^{-1})
1	14	1.0	0.041	0.076
2	20	1.0	0.040	0.067
3	28	1.0	0.030	0.077

* First-order velocity constant.

the formation of this complex. But an alternative interpretation is that peroxide is the specific substrate for peroxidase and that either peroxide itself or a derivative thereof is formed as an intermediate in the reaction of the other oxidizing agents with peroxidase. On this basis one would expect that these other agents, when compared with peroxide itself, would produce complex I more slowly, and would show a less favorable stoichiometry (a large ratio of oxidant utilized to complex produced) because of participation in side reactions with the enzyme itself.

When hydrogen peroxide reacts with peroxidase, complex I is formed in a very rapid reaction that has been shown to be of the second order ($10^7 M^{-1} \times sec^{-1}$) over a 40-fold range of peroxide concentrations (*2*). The stoichiometry of the reaction is correct, 1 $H_2O_2 \rightleftarrows 1$ Fe atom of peroxidase converted to complex I (*4*).

The kinetics and stoichiometry of the reaction of peroxidase with two oxidizing agents, chlorite and hypochlorite, have been studied (*5*). More than 100 times the quantity of these reagents is necessary to give half-maximal formation of complex I than is required when hydrogen peroxide is used. Chlorite forms a peroxidase intermediate at one twenty-fifth the rate obtained with peroxide. Thus, in both cases, the formation of intermediate peroxide is possible.

One-electron transfer reagents such as chloroiridate provide a much more critical test of the reaction mechanisms, and George reported the formation of an intermediate resembling complex I with this reagent (*3*). We here (*6*) report kinetic and titration studies with bromoiridate, which has been found to be a more satisfactory reagent than chloroiridate (*7*). The formation of complex I was measured at 403 mμ and the disappearance of bromoiridate was measured at 510 mμ.

Kinetic data. Table 1 shows that the first-order velocity constants for the disappearance of the bromoiridate and for the appearance of complex I are independent of the oxidant concentration over the available experimental range; no second-order reaction of oxidant and peroxidase is obtained as in the case of hydrogen peroxide.

Titration data. Figure 1 shows that there is a nonlinear relationship between the amount of oxidant consumed and the amount of complex I produced. Larger amounts of bromoiridate give relatively less of the complex. The maximum slope of the titration curve corresponds to > 4 $K_2IrBr_6 \rightleftarrows 1$ Fe atom of peroxidase converted to complex I. More than twice the theoretical amount of bromoiridate is required.

We found then that the formation of complex I from oxidizing agents other than hydrogen peroxide itself is either not a second-order reaction at all (bromoiridate) or is a second-order reaction over an order of magnitude slower than that caused by hydrogen peroxide (chlorite). The absence of a second-order rate law in the case of bromoiridate proves that intermediate reaction steps precede the formation of complex I. The slow second-order velocity constant in the case of chlorite allows time for intermediate reaction steps to occur. Mechanisms for peroxide production in similar reactions have been suggested by George (*8*), and other relevant possibilities are discussed by Evans and Uri (*9*). A practical aspect of the bromoiridate reaction is the finding (*7*) that this reagent attacks histidine as rapidly as it attacks peroxide and may act upon peroxidase by first combining with end groups of the protein. This would explain the unfavorable stoichiometry of the bromoiridate reaction (> 4 $K_2IrBr_6 \rightleftarrows 1$ Fe atom peroxidase) (*10*). In view of these data and other aspects of the peroxidase and catalase reactions (*11*), it appears premature to revise current views of enzyme-substrate specificity, and it is suggested that the term enzyme-substrate complex be retained for the present.

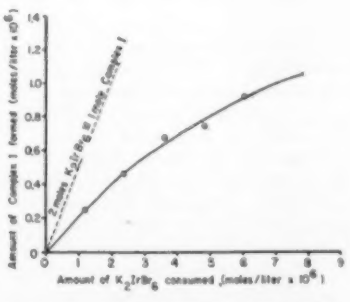


Fig. 1. Amount of complex I formed versus the amount of K_2IrBr_6 consumed. Initial (HRP): 1.19×10^{-6} moles $\times$ lit^{-1}; 0.01 moles $\times$ lit^{-1} borate (pH 9.2).

R. R. Fergusson
B. Chance
Eldridge Reeves Johnson Research Foundation for Medical Physics, University of Pennsylvania, Philadelphia

References and Notes

1. H. Theorell, in *The Enzymes*, B. Sumner and K. Myrback, Eds. (Academic Press, New York, 1951), vol. 2, part 1, p. 397.
2. B. Chance, *Arch. Biochem. and Biophys.* 22, 224 (1949).
3. P. George, *Science* 117, 220 (1953).
4. B. Chance, *Arch. Biochem. and Biophys.* 41, 416 (1952).
5. ———, *ibid.* 41, 425 (1952).
6. This work was supported in part by the National Science Foundation.
7. R. R. Fergusson, *J. Am. Chem. Soc.*, in press.
8. P. J. George, *Biol. Chem.* 201, 413 (1953).
9. M. G. Evans and N. Uri, *Symposia Soc. Exptl. Biol.* 5, 130 (1951).
10. Recently P. George has studied the oxidation of protein groups in hemoglobin by oxidizing agents [*J. Chem. Soc.* 1954, 587 (1954)].
11. B. Chance and R. R. Fergusson, in *The Mechanism of Enzyme Action*, W. D. McElroy and B. Glass, Eds. (Johns Hopkins Press, Baltimore, 1954), p. 389.

16 May 1955

Tetrapod Limb

I have just read with the greatest interest Grace Orton's note on the "Original adaptive significance of the tetrapod limb" (*1*). Romer (*2*) has suggested that the tetrapod limb arose as an adaptive modification that enabled the primitive amphibians to migrate from the receding pools of the Devonian countryside to areas where more water was retained. The tetrapod limb was an adaptation for terrestrial locomotion to permit the primitive amphibian to remain in the water. Orton has pointed out that such a suggestion seems to run counter to experience, for the behavior of modern amphibians is such that they will disperse only if the surrounding areas are sufficiently moist to attract them; if the adjacent areas are dry, modern amphibians tend to congregate in the dampest spots available. Such behavior is clearly the exact opposite to what might be expected were Romer's thesis correct, and Orton makes the alternative suggestion that the tetrapod limb was originally an adaptation for digging prior to estivation rather than for terrestrial locomotion.

Observations on the behavior of the South African Clawed Toad, *Xenopus laevis* (Daud.), together with some speculation, may help to throw some light on this problem. *Xenopus* is a typically

aquatic animal, inadept at walking on land and very susceptible to desiccation. Of interest here are the various types of behavior shown by *Xenopus* in response to the drying up of its normal habitats. Three distinct types of pattern have been described, one of which, although relevant, is clearly unnatural. First, the toad may estivate by burrowing in mud or possibly by being simply entombed (*3*). Such protection is in full keeping with Orton's suggestion. Second, and equally in line with Orton's view, is an account (*4*) of *Xenopus* emerging from muds of a duckpond that had been cleared out during the dry winter season and spread over some neighboring lawns. With the first rains, numerous toads emerged from the muds and wandered aimlessly in all directions, despite the presence of the newly filled duckpond some 20 yd away. Most of the animals died from exposure to the sun. Clearly their enforced terrestrial emergence left the animals defenseless against desiccation. The third and most interesting event is the description in the same paper of a migration across land of several thousand clawed toads from a dam that was commencing to dry up towards a nearby river. Such a migration as this is by no means unique, for I have heard several reports of sections of a main road being littered with the corpses of *Xenopus* that had been killed by passing cars.

Such then are the facts. To turn to speculation, it seems, first, highly probable that such a mass migration occurs only in favorable climatic conditions. Unfortunately there are no records on this point, but for the present let it be allowed as a hypothesis. Second, it seems likely that this sudden pattern of migration was not released simply by the dam commencing to dry up, for that is a common event that normally does not result in migration. Some other factor leading to migration must therefore be sought and the most obvious hypothesis, in the absence of evidence, is that the stimulus for migration arises from population pressure. If this is conceded, then clearly, with slight modification, Romer's hypothesis can stand. Increasing aridity caused migration from drying swamps, but the immediate stimulus for such a migration was population pressure resulting from the reduction in size of the habitable area. The migratory pattern was released by the stimulus of population pressure, but only provided that conditions for migration were suitable. It is clear that this latter restriction on the release of the migratory pattern would be very rapidly selected. If these assumptions are allowed, then we need not picture a set of behavior patterns in the early amphibians totally different from those that we encounter today, for in *Xenopus*, which is normally aquatic and capable of estivation in soft mud, we also find migratory behavior of a type that could be conducive both to survival and to the selection of more efficient limbs.

Finally, Orton's hypothesis does not appear to offer us any explanation of why the tetrapod limb, evolved in her view in relation to burrowing, should suddenly be used for walking. If we accept her viewpoint we still have to discover a further selective agency that turned a fossorial appendage to the service of seemingly unnecessary terrestrial locomotion.

D. W. EWER
Department of Zoology and Entomology, Rhodes University, Grahamstown, Union of South Africa

References

1. G. L. Orton, *Science* **120**, 1042 (1954).
2. A. S. Romer, *Vertebrate Palaeontology* (Univ. of Chicago Press, ed. 2, 1945).
3. W. Rose, *The Reptiles and Amphibia of Southern Africa* (Maskew Miller, Cape Town, 1950).
4. J. Hewitt and J. H. Power, *Trans. Roy. Soc. S. Africa* **3**, 147 (1913).

23 May 1955

Effect of Hematoporphyrin on X-radiation Sensitivity in Paramecium

When a cell divides, it synthesizes the pigment, protoporphyrin, to supply the daughter cells with the necessary quantity of heme compounds. Precursors of the erythrocytes produce this pigment in abundance and attach iron and globin to manufacture hemoglobin. Leukocytes and all other cells also produce protoporphyrin and attach iron and protein to manufacture various respiratory enzymes such as the cytochromes, catalase, and peroxidases. The naturally occurring porphyrins are, therefore, found in relatively high concentrations in embryonic, hemopoetic, traumatized regenerating and neoplastic tissues, many of which are radiation sensitive. Moreover, it has been found that these radiation-sensitive tissues have a great affinity for injected hematoporphyrin (*1*). Although protoporphyrin must be present in every cell at some stage of its development, a greater amount is present in cells that are undergoing division (*2, 3*).

It was thought by us that some of the porphyrins might have an effect on x-radiation sensitivity. It, therefore, seemed desirable to test the effect of hematoporphyrin on radiation sensitivity of *Paramecium*, which, besides being a single, isolated cell, is also a complex organism. Because these organisms are so radioresistant and for other reasons (*4, 5*), they proved to be excellent material for this study (*6*). Paramecia in control media require exceedingly high dosages of x-radiation to produce lethal effects. For *P. caudatum* the approximate LD-50 of 340,000 r, 24 hr, is about 850 times as great as the estimated LD-50 of man and some common vertebrate laboratory animals (*5*).

It was known that hematoporphyrin sensitizes paramecia to visible and ultraviolet light (*3*). Our experiments demonstrate in a conclusive way that porphyrin sensitizes paramecia to short wavelength radiations, such as x-rays. Even in extremely high dilutions, hematoporphyrin-treated specimens proved to be approximately 18 times as radiosensitive as the controls.

For each irradiation experiment, 200 paramecia were placed in each of four nylon hypodermic syringes of 2-ml capacity and were x-rayed simultaneously. The paramecia were well-fed (*Aerobacter aerogenes* in standard desiccated lettuce infusion) vegetative specimens from rich clonal cultures. The plastic syringes in a Plexiglas holding and cooling chamber were placed between two crossfired x-ray tubes operated at 182 kv peak at 25 ma with an equivalent filtration of 0.2 mm of copper and a delivery rate of 6300 r/min. The syringes absorb very little radiation, permit the introduction of hematoporphyrin in various concentrations, and facilitate accurate sampling of specimens during and after irradiation without changing the depth of the medium.

The dilutions of hematoporphyrin were prepared so that when they were mixed with an equal amount of the culture fluid containing the paramecia, concentrations of 1:20,000 to 500,000 could be achieved. Concentrations of 1:10,000 hematoporphyrin are occasionally toxic to paramecia, unless they are kept in

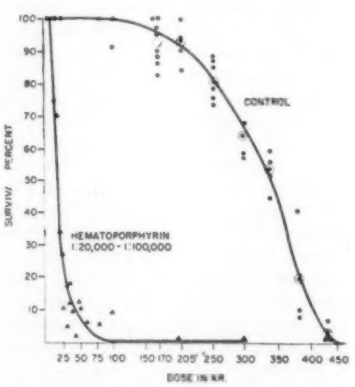


Fig. 1. X-ray survival curves for *P. caudatum* irradiated in nylon syringes. These curves are based on nine experiments. Each point in the curve represents observations on 10 to 25 counted specimens for at least 24 hr after irradiation. Control, ●; hematoporphyrin, ▲.

absolute darkness. No toxicity was ever observed in hematoporphyrin solutions in 1:20,000 in semidarkness; indeed, paramecia multiplied in such concentrations.

In the preliminary experiments, it was found that hematoporphyrin altered the radiation sensitivity in such a pronounced manner that it was difficult to find a radiation dosage that did not kill all the paramecia. For example, a dose of 85 kr killed all the animals in porphyrin solutions of 1:10,000 to 1:40,000 hematoporphyrin but not those in irradiated nonporphyrin control solutions. In another experiment using 1:20,000 hematoporphyrin solutions, 18 percent of the animals were killed with 34 kr and 90 percent were killed with a dose of 51 kr, whereas all the paramecia not treated with porphyrin survived a dose of 100 kr.

An examination of the data from later experiments revealed that all of the control paramecia, not treated with porphyrin, survived a dose of 100 kr, and that some died with greater dosages. In the lower concentrations of porphyrin of 1:200,000 and 1:500,000, all paramecia survived dosages up to 80 kr, but some died with higher dosages. It was noted that with higher concentrations of porphyrin, such as 1:20,000 to 1:100,000, all the animals survived only the relatively small doses of 5 to 20 kr, respectively.

Our results have been summarized in the form of two survival curves (Fig. 1). A comparison of the two curves indicates in a striking manner that hematoporphyrin sensitizes paramecia to x-radiation. The LD-50, 24 hr, of the control paramecia was 340,000 r, whereas the LD-50 of porphyrin-treated paramecia was only 18,000 r.

The possibility that lethality may have resulted from summation of toxic effects of hematoporphyrin and radiation was considered but was ruled out for several reasons. The effective concentrations of hematoporphyrin are not toxic, even when they are applied to the paramecia for 8 or 10 days. Moreover, the sensitizing influence varied directly with the concentration, and the dose of x-radiation that killed all or most paramecia in the presence of porphyrin (5 to 25 kr) is small when it is compared with the minimum lethal dose (100 kr) for control paramecia.

An additional observation made possible by the plastic-syringe method (5) is pertinent and of importance in other respects. The paramecia in the plastic syringes in porphyrin solutions were not killed by the relatively low doses of 20 to 80 kr, as long as they were retained in the syringe. When they were expelled and exposed to air in depression slides, they died within a period of 20 to 45 min. In one experiment, this feature was studied in some detail. After the necessary samples for counting and observation had been ejected into observation dishes, the remainder were left in the syringe to see how long they would survive in the syringe. The paramecia in a 1:20,000 solution of hematoporphyrin that had received a dose of 80 kr were still alive 22 hr later, but when they were ejected into observation dishes and exposed to air, they died within 45 min.

Thus, the sensitization of paramecia to radiation by hematoporphyrin is not a summation of toxic effects but an oxygen-dependent sensitization. The fact that oxygen is required and that it may be effective when it is added to the set of factors several hours after the period of irradiation is of greater interest and will be studied more extensively.

The hypothesis is therefore presented that one of the primary reasons for the increased x-radiation susceptibility of dividing cells is that they contain higher concentrations of porphyrin than do differentiated nondividing cells. In animals with transplanted tumors and in human cancer patients, the injection of hematoporphyrin causes the tumor tissue to accumulate even more porphyrin (*1*, *7*). The hope that the efficiency of radiation therapy of cancer may be improved by injections of hematoporphyrin is thus strengthened by these observations, which demonstrate in a conclusive manner that this chemical renders single cells, such as *Paramecium*, much more susceptible to the lethal effects of x-radiation.

FRANK H. J. FIGGE
Department of Anatomy, University of Maryland Medical School, Baltimore
RALPH WICHTERMAN
Department of Biology, Temple University, Philadelphia, Pennsylvania

References and Notes

1. F. H. J. Figge, G. S. Weiland, L. O. J. Manganiello, *Proc. Soc. Exptl. Biol. Med.* **68**, 640 (1948); G. C. Peck, H. P. Mack, F. H. J. Figge, *Bull. School of Medicine, Univ. of Maryland* **38**, 124 (1953); D. S. Rasmussen-Taxdal, G. E. Ward, F. H. J. Figge, *Cancer* **8**, 78 (1955).
2. F. H. J. Figge, *Cancer Research* **4**, 465 (1944).
3. H. Fischer and H. Orth, *Die Chemie des Pyrrols* (Akad. Verlagsgesellschaft, 1937), vol. II, 1st half.
4. R. Wichterman, *The Biology of Paramecium* (Blakiston, New York, 1953).
5. ——— and F. H. J. Figge, *Biol. Bull.* **106**, 253 (1954).
6. This work was supported by grants from the Anna Fuller Fund; the American Cancer Society, Maryland Division, Inc.; the National Institutes of Health (grants G-4063 and A-735C); the Committee on Research, Temple University, aided by contract 135–263 of the Office of Naval Research, Department of the Navy, and Temple University. All irradiation work was done at the Marine Biological Laboratory, Woods Hole, Mass. The detailed conditions in these and control experiments have been described in a previous paper (*5*).
7. F. H. J. Figge *et al.*, *Anat. Rec.*, **121**, 292 (1955).

10 February 1955

Mucunain, the Active Pruritogenic Proteinase of Cowhage

Cowhage is the name given to the short barbed hairs (trichomes) that cover the seed pods of the tropical plant *Mucuna pruriens*. An exquisitely effective stimulus for itching, cowhage has long been known as itch powder. This report (*1*) outlines our technique in extracting, isolating, and identifying the active pruritogenic principle of cowhage.

Untreated cowhage was extracted for 5 min with 0.9-percent aqueous sodium chloride solution (0.8 ml/100 mg). After vacuum filtration (Schleicher and Schuell, No. 602), 2 vol of absolute ethyl alcohol was added slowly while the extract was stirred. The resultant flocculent precipitate was removed 10 min later by centrifugation (1700 rev/min, 3 min), rapidly air-dried, and redissolved in 0.9-percent sodium chloride solution. Reprecipitation with methyl alcohol (2 vol) was done, and the final product was redissolved in half the volume of sodium chloride solution.

It was necessary to carry out all procedures at 0°C and to pay careful attention to reagent purity and glassware cleanliness. At all stages of isolation, activity checks were run by injecting 0.02 ml of solution intradermally. All fully active preparations produced an intense localized itch, which appeared after 5 to 10 sec and persisted for 3 to 5 min. This itch was of an entirely different order of magnitude than that experienced following electric stimulation or the injection of histamine or histamine liberators. It was accompanied by slight to moderate local whealing.

Study revealed that the "itch substance" was nondialyzable and extremely labile, suggesting a protein nature. Changes in *p*H, heating, or any simple denaturant process rapidly inactivated the extract. However, activity of any extract could be preserved for months by rapid drying at low temperatures or by freezing. Biological and chemical tests made for numerous pharmacologic agents led to the conclusion that an enzyme was responsible for the itch properties of cowhage. Following this, *amylase* was demonstrated in the initial aqueous extract of the *Mucuna* spicules but was shown to be present in fractions other than the purified pruritogenic one. Finally a broad spectrum proteinase was discovered to be present in all the active pruritogenic extracts and preparations. Furthermore, its activity was correlated with pruritus but not with urticaria. This proteinase, hitherto undescribed, has been named by us *Mucunain* to indicate its source and nature.

Mucunain attacks the following synthetic substrates (0.01*M* substrate, 60-min incubation at 35°C, *p*H 5 to 8,

M/15 Na. K phosphate buffer, 25-percent aqueous phenol ascending Whatman No. 1 paper chromatogram, ninhydrin): carbobenzoxy-glycyl-1-phenylalanine, carbobenzoxy-glycyl-1-phenylalanine amide, and carbobenzoxy-glutamyl-1-tyrosine. Under these conditions no activity could be shown against benzoyl argininamide, benzoyl glycinamide, benzoyl arginine methylester hydrochloride, or leucyl glycylglycine. In common with all proteinases, mucunain has the property of coagulating milk. It is neither activated nor inactivated by cysteine. No coenzyme or cofactor is known to be necessary.

Although Broadbent (*2*) claimed to have made an active extract of cowhage by boiling, we have been unable to confirm his work. Boiling destroys mucunain instantaneously. Furthermore, we have found that serotonin (5-hydroxytryptamine), which has recently been identified in cowhage (*3*), is without pruritogenic properties.

WALTER B. SHELLEY
ROBERT P. ARTHUR
Department of Dermatology,
University of Pennsylvania
Medical School, Philadelphia

References and Notes

1. This study was supported by Army contract DA-49-007-MD-154.
2. J. L. Broadbent, *Brit. J. Pharmacol.* **8**, 263 (1953).
3. K. Bowden, B. G. Brown, J. E. Batty, *Nature* **174**, 952 (1954).

12 January 1955

Metabolism of 3,4-Benzopyrene

In following up the earlier work of Chalmers and Peacock (*1*) Weigert and Mottram (*2*) demonstrated, in the excreta of mice injected with 3,4-benzopyrene, the presence of four distinguishable metabolites, X_1, X_2, F_1 and F_2. Of these, F_2 corresponded in its absorption spectrum and phenolic properties to the metabolic phenol 8-benzopyrenol, previously identified by Berenblum and Schoental (*3, 4*) and subsequently confirmed by synthesis (*5*). By analogy with anthracene, in which metabolic oxidation had been shown to undergo perhydroxylation with the formation of a diol (*6*), Weigert and Mottram (*2*) postulated the schematic metabolic pathway for 3,4-benzopyrene that is shown.

In fact, the nature of the metabolites X_1 and X_2 has not yet been established, and the suggestion that these represent derivatives of 8,9-dihydrodihydroxybenzopyrene does not seem justified. For instance, the long-wave systems of the absorption spectra of these two products (as reproduced in the publications of Weigert and Mottram) are very similar to those of fully aromatic benzopyrene derivatives, with their longest absorption bands *displaced to the red* in relation to those of benzopyrene, which is contrary to what one would expect if the 8,9 positions were hydrogenated. The assumption that F_1 is a conjugated 8-benzopyrenol is also unjustified, for its adsorption properties are not very different from those of F_2, while the fluorescence spectral bands, on the column, are displaced by about 7 mμ to the ultraviolet in comparison with those of F_2. In all these respects, F_1 appears to be indistinguishable from unconjugated 10-benzopyrenol (*4*), rather than a conjugated 8-benzopyrenol.

It remains to be shown whether the metabolites X_1 and X_2 represent respective conjugated products of the phenolic 10- and 8-benzopyrenols, and if so, what the nature of the conjugation compounds is. But the scheme of Weigert and Mottram, as it stands, not only lacks confirmation but is actually inconsistent with the known facts.

This note was prompted by the perpetuation in recent reviews and other works of reference (*7*) of Weigert's scheme, which, in the light of subsequent evidence, especially about the existence of 10-benzopyrenol and its probable identity with F_1, is no longer acceptable. Were it not for his untimely death, Weigert would no doubt have corrected the scheme himself.

I. BERENBLUM
Department of Experimental Biology,
Weizmann Institute of Science,
Rehovoth, Israel

R. SCHOENTAL
Cancer Research Department,
Royal Beatson Memorial Hospital,
Glasgow, Scotland

References

1. J. G. Chalmers and P. R. Peacock, *Biochem. J. London* **30**, 1242 (1936); J. G. Chalmers, *ibid.* **32**, 271 (1938); **34**, 678 (1940); J. G. Chalmers and D. Crowfoot, *ibid.* **35**, 1270 (1941).
2. F. Weigert and J. C. Mottram, *Cancer Research* **6**, 97, 109 (1946).
3. I. Berenblum *et al.*, *ibid.* **3**, 151 (1943).
4. I. Berenblum and R. Schoental, *ibid.* **6**, 699 (1946).
5. J. W. Cook, R. S. Ludwiczak, R. Schoental, *J. Chem. Soc.* 1112 (1950).
6. E. Boyland and A. A. Levi, *Biochem. J. London* **29**, 2679 (1935).
7. E. Boyland, *Biochem. Soc. Symposia Cambridge, Engl.* No. 5 (1950), p. 40; Elsevier's *Encyclopaedia of Organic Chemistry* **14**, Suppl., 706–711 (1951); G. Wolf, *Chemical Induction of Cancer* (Cassell, London, 1952); J. P. Greenstein, *Biochemistry of Cancer* (Academic Press, New York, 1954).

9 May 1955

Attempt to Reproduce Some of Moewus' Experiments on Chlamydomonas and Polytoma

During the stay of Franz Moewus and his wife in this laboratory, sympathetic and conscientious efforts were made by members of our group to repeat a number of his experiments. These involved monoecious and dioecious strains of *Chlamydomonas eugametos*, some mutants of the latter, and a monoecious strain of *Polytoma uvella*. Culture fluids of male and female *C. eugametos* and the compounds phenylalanine, rutin, isorhamnetin, and paeonin were utilized; for all of these, specific activities had been reported. The material and conditions used were those of Moewus, the experiments were of his choice, and he participated in some of them. Since, after 16 months no substantial confirmation of his claims is at hand, even for experiments originally performed by Moewus and his wife in this laboratory [F. Moewus, *Biol. Bull.* **107**, 293 (1954)], our attempts at repetition have been discontinued. A mimeographed description of the experiments that were done can be obtained from the present author.

FRANCIS J. RYAN
Department of Zoology,
Columbia University, New York

9 June 1955

Book Reviews

Electroacoustics. The analysis of transduction, and its historical background. Frederick V. Hunt. Wiley, New York; Chapman & Hall, London, 1954. viii + 260 pp. Illus. $6.

This fifth number of the Harvard Monographs in Applied Science combines an interesting, well-documented history of the evolution of electroacoustics with the theory of electroacoustic transduction as extended by the author and his coworkers at the Harvard Underwater Sound Laboratory from 1941 to 1946. Special attention is given to the author's recently modified formulation of the electromagnetic relationships, which permits a unified analytic and equivalent circuit presentation of all transducer types. The power and utility of this new approach are illustrated by applying it to the analysis of several transducer types.

The 91-page introductory chapter covers electroacoustic transduction and its relation to the electric communication art very thoroughly but in a lively narrative style. An interesting account of the beginnings of sonar is included. The author draws heavily on and makes a strong case for the use of patent literature as source material. He points out that many discoveries, inventions, and developments were first reported and others exclusively reported in patents. Although patents are primarily concerned with technologic improvements, the earlier patents in any art not infrequently contain disclosures of importance to science. Of interest to applied physicists is the case of the application of negative feedback by Maxfield and Harrison around the electromechanical transduction link as a method of increasing electrically the damping in a mechanical system. This was published in a 1925 patent—long before the broader principles of negative feedback were enunciated by others.

Some general aspects of electromechanical coupling are treated in a short chapter with that title. The third chapter is largely devoted to the antireciprocal aspects of the coupling coefficient in electromechanical transducers and an introduction to the author's space operator which allows all transducer types to be represented by the same form of equivalent circuit. The utility of this approach is illustrated in a chapter on "Electric-impedance analysis of transducer performance."

The last three chapters are devoted to the application of the new approach to the analysis of moving conductor, electrostatic, and moving-armature transducers. The treatment of electrostatic transducers is highlighted by the author's reported discovery that the force-displacement relationship in a push-pull unit approaches a linear one as the resistance of the bias supply circuit approaches infinity. The chapter on "Moving armature (magnetic) transducer systems" gives special attention to the fact that the coupling coefficient must be treated as a complex quantity. In most instances the usual approximation involving the assumption that the coefficient is a positive real is very unsatisfactory.

The author has gone to unusual lengths to ferret out and verify original sources. This is a conspicuous and laudable exception to the recent trend toward publishing books and papers of a survey nature with inaccurate and inadequate bibliographies which lead the reader to impute the historical material to the author or to an incorrect source. The detailed history, new historical material and mathematical treatment should interest many workers in the communication, audio, acoustic, and transducer fields.

HUGH S. KNOWLES
Industrial Research Products

A Million Random Digits with 100,000 Normal Deviates. The Rand Corporation. Free Press, Glencoe, Ill., 1955. xxv + 200 pp. $10.

The publication of these tables should meet at least two requirements that one frequently encounters in the scientific field: the need for an extensive set of random numbers, and the need for some assurance that the numbers used are random. Up to this time, a person has felt that he could at best satisfy only one of these requirements from existing tables.

The publication is in itself a very fine technical job. The size of the type used and the arrangement of the columns and digits should facilitate their use. The addition of 100,000 random normal deviates should prove particularly useful to individuals working in the field of statistics and needing random samples from a normal population to study empirically the distribution of some statistic.

The introduction not only provides interesting information on the method used to generate the random numbers but also describes the numerous tests made of the final results in testing for randomness. For those who are unfamiliar with the problem, I should mention that, although it sounds easy, one of the hardest tasks in this world is to evolve a random process. The satisfactory manner in which the Rand tables meet the numerous tests that they applied to the tables speaks well regarding their scientific worth. Some attention is given in the introduction to the problem of how to use the tables, especially those of the normal deviates. Users of the tables should note these sections carefully, since care is necessary in how one actually uses tables of this type.

As a final comment, one cannot help but be amused by the problem of proofreading the final tables to see whether the printing and reproduction mechanism has introduced "random" errors.

CARL F. KOSSACK
Statistical Laboratory,
Purdue University

Endothelium. Its development, morphology, function and pathology. Rudolf Altschul. Macmillan, New York, 1954. xi + 157 pp. Illus. $3.50.

This monograph developed as an outgrowth of the author's interest in arteriosclerosis, and it brings together much of the widely scattered literature on endothelium. This important tissue is discussed under the following chapter headings: "Historical notes and nomenclature," "Morphology," "Development," "Tissue culture," "Metaplasia," "Function," "Pathology," "Summary and conclusions." The chapter on the pathology of endothelium includes a discussion of tumors, inflammation, shock, hypertension, renal diseases, radiation effects, blood clotting, changes or abolition of circulation and arteriosclerosis. The book is well documented, although occasional references were advisedly omitted in order to keep the bibliography within 400 titles.

In my opinion, additional experimental data should have been presented in support of some of the statements quoted or conclusions drawn. Although these data would have lengthened the monograph, they would have made the text more valuable. For example, without additional supporting data, I would be unwilling to agree with the conclusions

drawn (p. 108) regarding the amitotic division of endothelium, the subsequent differentiation of these cells into mesenchymelike tissue, and later redifferentiation into fibroblast, smooth muscle and cartilage cells.

The author is to be congratulated for his broad approach to an important subject. The integration of cytology, cell physiology, and cell chemistry is prerequisite to a better understanding of the endothelial cells and to the many diseases that result from their derangement. This small monograph will be of value to both the research worker and the clinician interested in vascular disease.

ARNOLD LAZAROW
Department of Anatomy,
University of Minnesota

Antibiotics Annual 1954–1955. Henry Welch and Felix Marti-Ibanez, Eds. Medical Encyclopedia, New York, 1955. ix + 1154 pp. Illus.

It is incredible that so much information about antibiotics could be brought together in such a short period of time and published for the benefit of the interested reader. This annual contains 1154 pages of reading material on a wide range of subjects dealing with old, new, and untried antibiotics. The publication of this volume followed the second Annual Symposium on Antibiotics sponsored by the Food and Drug Administration of the Department of Health, Education, and Welfare which was held in October 1954. The President addressed a letter of good wishes to all those participating in the symposium.

For all those interested in antibiotics and for all physicians who use them, this annual will serve as a work of reference as well as a group of papers that will stimulate thought and new ideas.

CHESTER S. KEEFER
Boston University School of Medicine

The Chemistry of Synthetic Dyes and Pigments. H. A. Lubs, Ed. Reinhold, New York, 1955. xiv + 734 pp. Illus. $18.50.

Although this book was not intended as a single-company production, all of the 19 contributors to this extensive volume have been associated with the Jackson Laboratory of the Organic Chemicals Department of E. I. duPont de Nemours & Co. It is obviously a well-knit group of collaborators, for in many chapters four or five workers are credited with segments of the chapter, and the same collaborator appears in different chapters. The separate collaborators are not indicated in the table of contents but are identified in the sections that they prepared.

This compilation represents a very readable collection and assimilation of the many American and British intelligence team reports on the progress of dye synthesis in Germany prior to World War II, to which has been added much of the known technology in this and other countries in this same field.

The general discussion on colored chemical constitution and organic pigments and the extensive bibliography add much to the value of this book as a general reference to workers in other fields who desire knowledge of dyestuffs. Combination with such standard works as the forthcoming new edition of the *Color Index* or the *Yearbook of the American Association of Textile Chemists and Colorists* will permit easy "translation" into available commercial types.

In the organization of this extensive treatise, there is first presented a general discussion on aromatic intermediates. There follow separate discussions on the important dye classes, including azo, azoic, sulfur, anthraquinones, indigoid, and phthalocyanine and the general bibliographic and discussion sections mentioned in the preceding paragraph. In general the discussion concerns the indicated methods of production of known classes of dyes and modifications to give important variants to the basic type.

WALLACE R. BRODE
National Bureau of Standards

Organic Reactions. vol. VIII. Roger Adams, Ed. Wiley, New York: Chapman and Hall, London, 1954. viii + 437 pp. $12.

The latest volume of what has become a series of standard reference works for the organic chemist comprises eight chapters: "Catalytic hydrogenation of esters to alcohols" by the late Homer Adkins; "The synthesis of ketones from acid halides and organometallic compounds of magnesium, zinc, and cadmium" by David A. Shirley; "The acylation of ketones to form β-diketones or β-keto aldehydes" by Charles R. Hauser, Frederic W. Swamer, and Joe T. Adams; "The Sommelet reaction" by S. J. Angyal; "The synthesis of aldehydes from carboxylic acids" by Erich Mosettig; "The metalation reaction with organolithium compounds" by Henry Gilman; "β-Lactones" by Harold E. Zaugg; "The reaction of diazomethane and its derivatives with aldehydes and ketones" by C. David Gutsche.

The general format of each chapter follows closely the style that has become standard for the series. The book is definitely of interest and, indeed, is wellnigh indispensable to the practical organic chemist. With but few exceptions, mechanistic treatment of the reactions has been held to a minimum. Where a mechanistic discussion is given in some detail, it is necessary for proper interpretations and application of the reaction involved.

The long and exhaustive chapter on acylation of carbonyl compounds by Hauser and his associates provides a welcome survey of the host of applications of this important reaction. It supplements the earlier chapter on the Claisen condensation that appeared in volume II of the series.

The chapter on synthesis of aldehydes from carboxylic acids likewise supplements the earlier chapter on the Rosenmund reduction of acid chlorides that appeared in volume IV. With the discussion of indirect methods of reduction of a carboxyl group to an aldehyde, this important transformation has now been completely covered.

The chapter on β-lactones provides information not only on the modes of synthesis of these interesting compounds but, what is perhaps more important, on the uses to which they can be put in further syntheses.

The volume maintains the high standard of its predecessors. About the only criticism that can be made is that in a few of the chapters, the literature survey has not been brought forward as far as could have been possible and desirable. This is particularly noticeable in Chapter 1; the shortcoming is undoubtedly due to the untimely death of Professor Adkins. Likewise, in Chapter 2, complete literature coverage is claimed only up to mid-1950.

ROBERT C. ELDERFIELD
Department of Chemistry,
University of Michigan

Electrolyte Solutions. The measurement and interpretation of conductance, chemical potential and diffusion. R. A. Robinson and R. H. Stokes. Academic Press, New York, 1955. xiii + 512 pp. Illus. $9.50.

This volume is the American edition of the book published by Butterworths Scientific Publications of London. The authors, R. A. Robinson, professor of chemistry at the University of Malaya, and R. H. Stokes, reader in physical chemistry at the University of Western Australia, are active workers in the field of electrolytic solutions. They have written a lively, stimulating book: a book

that makes no pretense to being an exhaustive treatise on electrolytes but is, rather, a critical, detailed account of some of the most important aspects of the subject presented with refreshing vigor. Although it is not, properly speaking, a textbook, graduate students and particularly those who have more than a cursory interest in the electrochemistry of solutions will welcome this book.

The subjects discussed from both an experimental and theoretical point of view are conductance, chemical potential, and diffusion. A considerable amount of critically selected experimental data is included covering a substantial range of concentration. The theoretical treatments are based on the Gibbs free energy, on the Debye-Hückel interionic attraction theory, and on the work of Onsager, Fuoss, and Falkenhagen. The authors have attempted to extend the theoretical limiting dilute solution equations to practical concentrations with some success. However, I cannot agree that these extensions are not empirical. Thus, although the manner in which they introduce the ion size factor for the electrophoretic term of the Onsager conductance equation is theoretically valid, it does not appear to be so for the ionic relaxation term. Fuoss and Onsager have recently pointed out that in the latter case a transcendental function appears which cannot be approximated in such a simple manner. But this new theoretical development appeared after the publication of the book and should not detract from its very substantial merits.

THEODORE SHEDLOVSKY
Rockefeller Institute for Medical Research

Papirova Chromatografie. I. M. Hais and K. Macek, Eds. Czechoslovakian Academy of Sciences, Prague, 1954. 720 pp. Illus.

Although this book is not easily available in this country and is written in Czechoslovakian, it seems desirable to review it here as a matter of scientific interest. I was fortunate in obtaining the services of H. Korbel, who carefully translated a chosen 15 percent of the text. On the basis of this translation, the copious illustrations, and a table of contents supplied by the editors, this review is written.

The book is the work of 23 collaborators, two of whom are the editors. The selection of material for the book was made partly on the basis of methods worked out and checked by the authors of the various chapters or else compiled from the literature. The literature cited in the text was as complete as possible up to early 1953, and references accumulated between March and September 1953 were included in the bibliography. There are 3795 literature references cited, with the titles given in the language of original publication. This makes it possible for the reader who is limited to English, German, and French to understand the majority of the references, for most are in these languages. There are 243 pictures and diagrams, including eight pages of black-and-white plates and two pages in color at the end of the book. There are 73 tables in the text and, at the end of the text, some 19 pages of detection agents (177 of them) and 11 pages of solvent systems (241 of them). The book is then, within the time limitations, the most complete work on this subject that has yet appeared.

The most important characteristic of the book is the approach that it takes to paper chromatography. The subject is treated as a science. The authors analyze logically the background material and the great diversity of observations on paper chromatography and draw what generalizations seem permissible, always giving examples to illustrate their meaning. The result is that, although there are many aspects of paper chromatography that are not well understood, so much is brought into an ordered form and so much else in addition is given a rational explanation that the reader is left with great confidence in the method, and with the feeling that its problems have solutions that he can arrive at following the precepts of others as described in this book. The authors describe applications of chromatography primarily in order to help the reader solve his own problems.

Of what value can a book like this be for a person who does not read Czechoslovakian? The greatest value, that described in the preceding paragraph, is largely lost to him. However, much value still remains. The book has the most complete bibliography available, which can be read since the majority of the titles are in English, French, or German. There are also references to publications in Czechoslovakian and to Soviet journals which indicate that much work in this area is going on in those countries. Most of the tables and lists of detection agents and solvents are useful to the reader, because international chemical nomenclature is used, and because references are given to literature in the more widely current languages. Also, with a dictionary, all the large number of figures and photographs become available. Hence, even though the text may be hard going, a tremendous amount of material that is not collected in this way elsewhere is available to the reader.

It is scientifically most unfortunate that the authors of this book, when they undertook such a monumental task, should have chosen to publish it in a language of only local interest scientifically. It is to be hoped that when a new edition is forthcoming it will be published in German, or better yet in English. One essential of scientific progress is communication.

HAROLD G. CASSIDY
Department of Chemistry, Yale University

The Method of Trigonometrical Sums in the Theory of Numbers. I. M. Vinogradov. Trans. by K. F. Roth and Anne Davenport. Interscience, New York–London, 1954. x + 180 pp. $5.

This book, so ably edited by K. F. Roth and Anne Davenport, is an account of the so-called "method of exponential sums" introduced by Vinogradov. It is well known that this method has helped to solve many outstanding problems of additive number theory and analytic number theory. To give an example, Goldbach conjectured in 1742 that every large odd number can be represented as a sum of three prime numbers. This is proved, with almost complete details, in Chapter 10 of the present book. Another problem of great interest is whether it is true, and the reader can check without difficulty the truth for small values of x, that there exists at least one prime between x^2 and $(x+1)^2$, where x denotes a natural number. While this is still unsettled, a somewhat weaker theorem—namely, that there exists at least one prime between x^3 and $(x+1)^3$ for all large values of x, has been proved by the British mathematician A. E. Ingham, using Vinogradov's estimates on trigonometric sums.

It should, perhaps, be mentioned that the methods of Vinogradov are very heavy and complicated, and that the estimates he obtains for exponential sums are, at least sometimes, very far from the probable truth. To give an example, let $f(x) = a_n x^n + a_{n-1} x^{n-1} + \ldots + a_0$ be a polynomial with integer coefficients, where a_n is not divisible by the prime p. Then A. Weil's recent proof of the Riemann hypothesis in function fields implies that

$$\left| \sum_{x=1}^{p} e^{2\pi i f(x)/p} \right| \leqq (n-1)\sqrt{p}$$

So far as is known, this deep result lies beyond the range of Vinogradov's method. However, Vinogradov's results still give the best information, to date, on the root-free regions of the classical zeta-function of Riemann in the critical strip!

The translators must be congratulated

on this important addition to literature in the analytic theory of numbers. One should not omit to remark that the annotations are extremely helpful to the reader.

S. CHOWLA
Department of Mathematics,
University of Colorado

Preservation and Transplantation of Normal Tissues. G. E. W. Wolstenholme and Margaret P. Cameron, Eds. Little, Brown, Boston, 1954. xii + 236 pp. Illus. + plates. $6.

This book is comprised of papers presented at an international symposium held by the Ciba Foundation in March 1953. The ensuing discussions are also included. The coverage is broad and includes papers on the general problems of immunity and tissue culture and the problems connected with the storage, preservation, and grafting of such structures as gonads, parathyroids, skin, nerves, blood vessels, and cornea.

Books Reviewed in The Scientific Monthly

September

Advances in Virus Research, K. M. Smith and M. A. Lauffer (Academic). Reviewed by M. H. Adams.

From Classical to Modern Chemistry, A. J. Berry (Cambridge Univ. Press). Reviewed by L. W. Elder, Jr.

Animal Form and Function, W. R. Breneman (Ginn). Reviewed by D. R. Newth.

My Way of Becoming a Hunter, R. H. Rockwell and J. Rockwell (Norton). Reviewed by C. H. Rogers.

A Manual of the Dragonflies of North America (Anisoptera), J. G. Needham and M. J. Westfall, Jr. (Univ. of California Press). Reviewed by C. D. Michener.

Conserving Natural Resources, S. W. Allen (McGraw-Hill). Reviewed by P. B. Sears.

Mammals of California and Its Coastal Waters, L. G. Ingles (Stanford Univ. Press). Reviewed by K. R. Kelson.

The Material Culture of Pueblo Bonito, N. M. Judd (Smithsonian Institution). Reviewed by P. S. Martin.

Paracas Fabrics and Nazca Needlework, 3rd century B.C.*–3rd century* A.D., J. Bird and L. Bellinger (National Pub.). Reviewed by C. Evans.

An Introduction to Psychology, H. W. Karn and J. Weitz (Wiley). Reviewed by J. W. Gustad.

Cherries and Cherry Products, R. E. Marshall (Interscience). Reviewed by C. S. Waltman.

Development of the Guided Missile, K. W. Gatland (Iliffe; Philosophical Library). Reviewed by H. S. Seifert.

Charles Darwin and the Golden Rule, The late W. E. Ritter, E. W. Bailey, Ed. (Science Service; Storm). Reviewed by K. P. Schmidt.

Prehistoric Stone Implements of Northeastern Arizona, R. B. Woodbury (Peabody Museum of American Archaeology and Ethnology). Reviewed by E. K. Reed.

Relativity for the Layman, J. A. Coleman (William-Frederick). Reviewed by P. G. Bergmann.

Cancer: Race and Geography, P. E. Steiner (Williams & Wilkins). Reviewed by C. P. Rhoads.

Foreign Policy Analysis, F. Gross (Philosophical Library). Reviewed by R. Braibanti.

Excavations at Star Carr, J. G. D. Clark (Cambridge Univ. Press). Reviewed by M. J. Mellink.

Auxins and Plant Growth, A. C. Leopold (Univ. of California Press). Reviewed by W. P. Jacobs.

New Books

Dictionary of Legal Terms, Spanish-English and English-Spanish. Louis A. Robb. Wiley, New York; Chapman & Hall, London, 1955. 228 pp. $8.

Laplace Transforms for Electrical Engineers. B. J. Starkey. Iliffe, London, 1954; Philosophical Library, New York, 1955. 279 pp. $10.

The Josiah Macy, Jr. Foundation, 1930–1955. A review of activities. The Foundation, New York, 1955. 174 pp.

The Chemistry and Fertility of Sea Waters. H. W. Harvey. Cambridge Univ. Press, London, 1955. 224 pp. $5.50.

Experimental Psychology. A series of broadcast talks on recent research. B. A. Farrell, ed. Philosophical Library, New York, 1955. 66 pp. $2.75.

Soil Warming by Electricity. R. H. Coombes. Philosophical Library, New York, 1955. 116 pp. $4.75.

Forestry and Related Research in North America. Frank H. Kaufert and William H. Cummings. Soc. of American Foresters, Washington, D.C., 1955. viii + 280 pp. $5.

Plant Ecology. Reviews of Research. Arid Zone Research, VI. UNESCO, Paris, 1955. 377 pp. $7.

Chemical Engineering Cost Estimation. Robert S. Aries and Robert D. Newton. McGraw-Hill, New York, 1955. 263 pp. $6.

Climates in Miniature. A study of Micro-climate and environment. T. Bedford Franklin. Philosophical Library, New York, 1955. 137 pp. $3.75.

Midwest and Its Children. The psychological ecology of an American town. Roger G. Barker and Herbert F. Wright. Row, Peterson, Evanston, Ill., 1954. 532 pp. $7.50.

Proceedings of the UNESCO Symposium on Typhoons, 9–12 November, 1954, Tokyo. Japanese National Commission for UNESCO, Tokyo, 1955. 257 pp.

Cardiovascular-Renal Problems. vol. 1, *Clinical Pathologic Conferences of Cook County Hospital.* Hans Popper and Daniel S. Kushner, Eds. Blakiston-McGraw-Hill, New York, 1954. 325 pp. $5.

Miscellaneous Publicatons

(Inquiries concerning these publications should be addressed, not to Science, but to the publisher or agency sponsoring the publication.)

Frogs of Southeastern Brazil. Bull. 206. Doris M. Cochran. Smithsonian Inst., Washington, 1955. 423 pp. $2.

Archives de l'Institut Pasteur de Madagascar. Rapport Annuel, 1954. The Inst., Madagascar, 1955. 78 pp.

Israel's Science Bibliography. vol. 1, No. 1, Jan.–June 1954. Miriam Balaban, Ed. Israel Scientific Press, Jerusalem. 37 pp. $1.25 (order from Interscience, New York–London).

Geochronology. With special reference to southwestern United States. Terah L. Smiley, Ed. Univ. of Arizona Press, Tucson, 1955. 200 pp. $1.50.

A Description of Two Species of Bonito Sarda orientalis *and* S. chiliensis *and a Consideration of Relationships within the Genus.* Fish Bull. No. 99. H. C. Godsil. California Dept. of Fish and Game, 1955. 43 pp.

Catch Localities for Pacific Albacore (Thunnus germo) *Landed in California, 1951 through 1953.* Fish Bull. No. 100. Harold B. Clemens. California, Dept. of Fish and Game, 1955. 28 pp. *Age Determination of the Northern Anchovy,* Engraulis mordax. Fish Bull. No. 101. California, Dept. of Fish and Game, 1955. 66 pp.

Control of DDT-Resistant Potato Flea Beetles. Circ. 193. James B. Kring. Connecticut Agricultural Expt. Sta., New Haven, 1955. 23 pp.

An Evaluation of the Red Fox. Biological Notes No. 35. Thomas G. Scott. Illinois National History Survey, Urbana, 1955. 16 pp.

Moderne Therapie der Anämien. Nach pathogenetischen Tesichtspunkten. Walter Tischendorf. S. Hirzel Verlag, Stuttgart, 1955. 114 pp. DM. 14.

Organization and Administration of the Military Research and Development Programs. House Rept. No. 2618, 83rd Congress 2nd session. Twenty-fourth Intermediate Report of the Committee on Government Operations. Supt. of Documents, GPO, Washington, D.C., 1954. 72 pp.

Index to Hearings before the Joint Committee on Atomic Energy, Congress of the United States, Eighty-fourth Congress, First Session, on Development, Growth, and State of the Atomic Energy Industry. The Committee, Washington, D.C., 1955. 17 pp.

Disposal of Government-Owned Community at Richland, Wash. pt. 2. Hearing before an ad hoc subcommittee on disposal of government-owned communities, Joint Committee on Atomic Energy, Congress of the United States, Eighty-fourth Congress, first session. The Committee, Washington, D.C., 1955. 241 pp.

Report on the Security Problem. By a subcommittee of the Committee on Government Operations, U.S. Senate, in support of Senate Joint Resolution 21 to establish a commission on government security. (Reprinted from the *Congressional Record*) Fund for the Republic, New York, 14 pp.

Scientific Meetings

French Association for the Advancement of Science

The New University of Caen was host, 15–22 July, for the 74th Congress of the French Association for the Advancement of Science. The congress was held under the patronage of the President of the Republic, a former student at the university.

It was on 7 July 1944 that the University of Caen was completely demolished during the bombing of the city in World War II. Since that day, 11 years ago, the university has been built anew from the ground up, showing no trace, ruin, or remnant of the 500 years of its earlier existence. The new buildings, on a hillside overlooking the center of the city—so modern that even interior classroom walls are made of glass brick—have won a Grand Prix at Rome for the architects. According to present plans, the campus will extend down the slope of the hill to join the park that surrounds the city's ancient chateau.

About 450 people came to Caen for the congress, the first large gathering of its kind, in the newly rebuilt university. Members came from Belgium, Italy, Switzerland, Holland, England, the Saar, Canada, Greece, Algeria, South Africa, the United States, and France.

President of the congress was M. L. Binet, doyen of the Faculty of Medicine at Paris, member of the Institut and of the National Academy of Medicine. The subject of the presidential address was "Man, creature of God." After the opening ceremonies, members of the congress were taken on a tour of the city, which ended with a reception given by the mayor of Caen in honor of the visiting scientists.

For the presentation of contributed papers, the congress was divided into 26 sections—mathematics, mechanics, astronomy, physics, chemistry, physical chemistry, and so forth. The first session for contributed papers was held on 16 July. A recess was then taken for a 2-day excursion to Rouen and other nearby points of interest.

The section on the history of science with René Taton of the National Center for Scientific Research as president was particularly active. This section met on 4 different days. A large number of papers were presented, discussion was vigorous, and attendance reached a total of about 50 persons. The central theme of the section was "The teaching of science in the 18th century."

General sessions were held for the presentation of three additional featured addresses as follows: "Prospects for the use of atomic energy in France" by M. Gueron, director of the Atomic Energy Commission of France; "The presence and effect of antibiotics in milk" by M. Jacquet, professor at the Faculty of Sciences at Caen; and "The newly discovered scientific importance of certain metals, particularly, titane, tantale, and germanium" by M. Chrétien, professor at the Sorbonne.

A set of 14 excursions had been arranged for the pleasure of the members of the congress. Some of these had been planned as field trips for certain sections: for example, botany, geology, archeology; and others were planned as general tourist excursions, with several scientists giving brief lectures on their special fields of interest along the way. The terminal excursion was a 3-day trip covering a wide range of interests. On the first day members visited the points of debarkation of the Anglo-American forces on the Normandy beaches, the busy new St. Lo, and the Debarkation Museum at Arromanches. The second day was spent in a delightful visit to the Island of Jersey, and the highlight of the third day was a visit to Mont St. Michel.

In 1956 the AFAS congress will meet at Dijon.

LAURA GUGGENBUHL
Hunter College, New York

Meeting Notes

■ More than 300 surgeons from 42 countries met in Stockholm at the beginning of August for the 1st International Plastic Surgery Congress. The host organization was the Scandinavian Association of Plastic Surgery. At the opening session speeches were delivered by the president of the congress, P. A. Aschan, of Helsinki; the director general, Arthur Engel, head of the Swedish Medical Board; and Harold Gillis, English pioneer in plastic surgery. One of the chief considerations of the congress was the formation of an international union, to be called the International Society of Plastic Surgery.

Approximately 100 papers were read, and some 50 films were shown. Much interest was centered on burn injuries caused by atomic radiation. It was emphasized that serious burns, when the patient himself has no skin to spare, still present great difficulties to surgeons and that intensive research work is being conducted on the transplanting of skin from one person to another.

One of the chief tasks of plastic surgery in peacetime is the treatment of congenital defects, primarily harelip and split palate. In Sweden alone about 150 children are born with these defects annually. Harelip is hereditary, but today even most serious cases can be cured through close teamwork between plastic surgeons, dentists, and speech therapists.

■ The department of chemistry of the Polytechnic Institute of Brooklyn has announced that a symposium on Recent Developments in Valence Theory will take place at the institute on 1 Oct. Speakers will include J. C. Slater of Massachusetts Institute of Technology, W. E. Moffitt of Harvard University, R. E. Rundle of Iowa State College, and H. S. Gutowsky of the University of Illinois. For further information, communicate with Prof. E. Banks, Department of Chemistry, Polytechnic Institute of Brooklyn, 99 Livingston St., Brooklyn, New York.

■ Papers are invited for the 4th annual Semiconductor Symposium of the Electrochemical Society, which is to be held 29 Apr.–3 May 1956 at the Mark Hopkins Hotel in San Francisco, Calif. The preliminary plan is to divide the sessions as follows: (i) two half-day sessions on semiconducting materials—elemental, alloys, and compounds; (ii) a half-day session on surface controlled phenomena; and (iii) a half-day session on chemical process technology.

In each of the areas of interest the society would like to present a balanced agenda that includes: one review paper of the state of each field; 30-minute presentations (including discussion time) of new information that can be scheduled by midwinter 1955; and a number of short presentations of about 10 minutes' duration of the "late news" type. Those wishing to present papers should notify the chairman of the symposium, J. W. Faust, Jr., Westinghouse Research Laboratories, Beulah Road, Pittsburgh 35, Pa. The title of a proposed paper *must be submitted by 15 Nov.*, and an abstract of approximately 75 words must be received *no later than 15 Jan.*

The general chairman should be notified as soon as it appears likely that an investigator will be able to present a

"late-news" paper, the title or general area of interest should be provided, and a 75-word abstract must be prepared *before 8 Apr. 1956.*

■ The pharmaceutical industry will be the subject for the 5th annual meeting of the Industrial Council, which will be held at Rensselaer Polytechnic Institute on 27–29 Oct. The council is a national forum, organized by R.P.I. and supported by industry, that devotes itself each year to discussion of a major industry.

Robert A. Hardt, vice president of Hoffman-LaRoche, Inc., Nutley, N.J., and program chairman for the forthcoming sessions, has announced that the four keynote addresses will be delivered by Pierre A. de Tarnowsky, vice president, Mead Johnson and Co.; Theodore G. Klumpp, president, Winthrop-Stearns, Inc.; Raymond M. Rice, executive director of medical research, Eli Lilly and Co.; and Ernest H. Volwiler, president, Abbott Laboratories.

The meeting will be attended by about 1000 educators, chiefly social science teachers. More than 100 moderators and panelists are being invited to lead the discussions, which will deal with the industry's role in problems that confront the world. The aim of the council is to establish better understanding between industry and education.

■ A conference on tissue elasticity took place in Hanover, N.H., where some 30 scientists gathered on 1 Sept. for a 3-day discussion of the ability of certain living tissues to expand or to stretch when placed under stress. Sponsored by the National Science Foundation, the meeting was under the direction of John W. Remington, professor of physiology at the Medical College of Georgia. Allen L. King, a biophysicist and a professor at Dartmouth College, was responsible for conference arrangements.

■ Asia's first rural reconstruction conference opened in Tokyo on 22 Aug. Some 42 delegates from 10 nations discussed agricultural techniques for increasing food supply. Shiroshi Nasu of Japan was elected chairman of the 5-day session, which was attended by representatives from the Philippines, South Vietnam, Thailand, India, Indonesia, Pakistan, Cambodia, Formosa, and Malaya.

■ When the 5th Pan American Congress of Ophthalmology meets in Santiago, Chile, 9–14 Jan. 1956, the following subjects will be discussed by panels of physicians from North, Central, and South America: glaucoma, collagen diseases, infantile glaucoma, secondary glaucoma, strabismus, detachment of the retina, psychosomatic ophthalmology, tropical diseases of the eye, physiopathology and surgery of the crystalline lens, plastic surgery, visual fields and neuro-ophthalmology, and intraocular tumors. Papers will be presented in Spanish, Portuguese, and English, with simultaneous translations.

The congress will include a scientific exhibit, a display of ophthalmologic literature, and a program of scientific films related to diseases of the eye. Ophthalmologists who desire further information about the program may consult Dr. James H. Allen, 1430 Tulane Ave., New Orleans, La. Inquiries about other phases of the congress may be addressed to the acting secretary for countries north of Panama, Dr. Daniel Snydacker, 109 N. Wabash Ave., Chicago 2, Ill.

Forthcoming Events

October

6–8. National Science Teachers Assoc., Austin, Texas. (R. H. Carleton, NSTA, 1201 16 St., NW, Washington 6.)

6–8. Optical Soc. of America, Pittsburgh, Pa. (A. C. Hardy, Room 8-203, Massachusetts Inst. of Technology, Cambridge 39.)

6–8. Soc. of Industrial Designers, 11th annual, Washington, D.C. (S. G. Swing, SID, 48 E. 49th St., New York 17.)

6–8. Texas Science Fair Work Conf., Austin. (D. E. Large, Science Fair Program, P.O. Box 117, Oak Ridge, Tenn.)

9–13. Electrochemical Soc., Pittsburgh, Pa. (H. B. Linford, 216 W. 102 St., New York 25.)

9–14. American Acad. of Ophthalmology and Otolaryngology, Chicago, Ill. (W. L. Benedict, 100 First Avenue Bldg., Rochester, Minn.)

10–12. American Acad. for Cerebral Palsy, annual, Memphis, Tenn. (R. A. Knight, AACP, 869 Madison Ave., Memphis 3.)

10–12. American Oil Chemists' Soc., Philadelphia, Pa. (Mrs. L. R. Hawkins, AOCS, 35 E. Wacker, Dr., Chicago 1, Ill.)

10–12. National Prestressed Concrete Short Course, 1st, St. Petersburg, Fla. (A. M. Ozell, Civil Engineering Dept., Univ. of Florida, Gainesville.)

10–13. National Clay Conf., 4th, University Park, Pa. (T. F. Bates, College of Mineral Industries, Pennsylvania State Univ., University Park.)

10–21. New York Acad. of Medicine Graduate Fortnight on Problems of Aging, New York (R. L. Craig, 2 East 103 St., New York 29.)

11. Illinois State Geological Survey, 50th anniversary, Urbana, Ill. (J. C. Frye, 121 Natural Resources Bldg., Univ. of Illinois, Urbana.)

12–13. Symposium on Phospholipids, London, Ontario. (R. J. Rossiter, Dept. of Biochemistry, Univ. of Western Ontario, London, Ont.)

13. Assoc. of Vitamin Chemists, Chicago, Ill. (M. Freed, 4800 S. Richmond, Chicago 32.)

13–15. Canadian Physiological Soc., annual, London, Ontario. (J. M. R. Beveridge, Dept. of Biochemistry, Queen's Univ., Kingston, Ont.)

13–15. Indiana Acad. of Science, Notre Dame. (W. A. Daily, Eli Lilly and Co., 740 S. Alabama St., Indianapolis 6, Ind.)

14–15. National Soc. of Professional Engineers, Memphis, Tenn. (K. E. Trombley, NSPE, 1121 15 St., NW, Washington 5.)

16. American College of Dentists, San Francisco, Calif. (O. W. Brandhorst, 4221 Lindell Blvd., St. Louis, Mo.)

16–19. Soc. of American Foresters, Portland, Ore. (H. Clepper, 425 Mills Bldg., Washington 6.)

17–19. Detroit Institute of Cancer Research, 8th annual, Detroit, Mich. (Wm. L. Simpson, 4811 John R St., Detroit 1.)

17–20. American Dental Assoc., annual, San Francisco, Calif. (H. Hillenbrand, 222 E. Superior St., Chicago 11.)

17–21. National Metal Exposition and Cong., Philadelphia, Pa. (C. L. Wells, 7301 Euclid Ave., Cleveland 3, Ohio.)

18. American Soc. of Safety Engineers, annual, Chicago, Ill. (J. B. Johnson, 425 N. Michigan Ave., Chicago 11.)

18. Oak Ridge Inst. of Nuclear Studies, council meeting, Oak Ridge,Tenn. (W. G. Pollard, P. O. Box 117, Oak Ridge.)

18–19. National Acad. of Economics and Political Science, Washington, D.C. (D. P. Ray, Hall of Government, George Washington Univ., Washington 6.)

18–20. Entomological Soc. of Canada and the Acadian Entomological Soc., annual joint meeting, Fredericton, New Brunswick. (R. H. Wigmore, Science Service Bldg., Ottawa, Canada.)

18–21. American Dietetic Assoc., annual, St. Louis, Mo. (R. M. Yakel, ADA, 620 N. Michigan Ave., Chicago 11, Ill.)

19–21. International Conf. on the Use of Antibiotics in Agriculture, Washington, D.C. (H. I. Cole, National Research Council, Div. of Biology and Agriculture, 2101 Constitution Ave., Washington 25, D.C.)

19–21. Symposium on Applications of Radioactivity in Food and Food Processing Industries, Boston, Mass. (W. A. Stenzel, Tracerlab Inc., 130 High St., Boston 10.)

20–21. National Noise Abatement Symposium, 6th annual, Chicago, Ill. (R. W. Benson, Armour Research Foundation, Illinois Inst. of Technology, Chicago.)

22. American Mathematical Soc., College Park, Md. (AMS, 80 Waterman St., Providence 6, R.I.)

22–24. American Heart Assoc., 28th annual scientific session, New Orleans, La. (Medical Director, AHA, 44 E. 23 St., New York 10.)

24. American Ethnological Soc., New York, N.Y. (Miss A. G. James, 695 Park Ave., New York 21.)

24–26. National Conf. on Standards, 6th, Washington, D.C. (G. P. Paine, ASA, 70 E. 45 St., New York 17.)

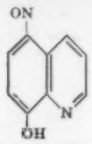
24–28. American Soc. of Civil Engineers, New York, N.Y. (W. N. Carey, ASCE, 33 W. 39 St., New York 18.)

(*Continued on page 478*)

Kodak reports to laboratories on:

a reagent that didn't work for metals but spot-tests phenols . . . a movie projector that brightens up at sound speed . . . an old technique for color photomicrography of colorless objects

5-Nitroso-oxine on the spot



5-Nitroso-8-quinolinol has been tried and found wanting as a chelating reagent for metals. Unnitrosated *8-Quinolinol*, better known as "oxine" or Eastman 794, has been long known as an effective metal precipitant but notoriously non-specific. The nitrosation succeeds in preventing precipitation of Al, Ga, In, and Mg but also removes the assurance of quantitative precipitation of the commoner metals. You can read all about it in a richly learned but discouraged paper appearing in *The Analyst* for April '55.

Still we do not despair of selling our *5-Nitroso-8-quinolinol* (Eastman 7097), for on page 133, Volume II, of Feigl's great "Qualitative Analysis by Spot Tests" (4th edition) it says that if one drop of a 1% solution of this compound in concentrated sulfuric acid is dropped onto a dried drop of alkaline test solution and then gently warmed, the following quantities of phenols reveal themselves by forming indophenols of the following hues:

dark brown: 1γ phenol
red-violet: 2γ resorcinol
black: 7γ pyrogallol
greenish-black: 4γ pyrocatechol
green-yellow: 5γ o-nitrophenol
dark brown: 5γ o-cresol
violet: 5γ xylenol
dark brown: 10γ α-naphthol
(1γ = 1 microgram)

This is typical Feigl analysis—exquisite, low-budget, and compact enough to be worked in a phone booth.

We hope everybody buys the book from Elsevier Press, Inc. (2330 Holcombe Blvd., Houston 25, Texas) and the reagents from our stock of some 3500 organic chemicals. Distillation Products Industries, Eastman Organic Chemicals Department, Rochester 3, N. Y. (Division of Eastman Kodak Company).

Invention

Unless you are getting a projector for personal movies only, it's a pity not to get a sound projector so that you can take advantage of the wealth of sound-and-color films available today from all sorts of sources on all sorts of subjects. It used to be that projectors capable of showing both silent and sound 16mm movies would waste 40% of their light at the 24-frames-per-second sound speed. At the standard 16-frames-per-second speed of 16mm silent movies, three interruptions of the light per cycle are required in order to exceed the critical frequency of 40 at which, under the average brightness and visual field in projection situations, the perception of flicker vanishes. But at 24 frames/sec, two interruptions of the shorter cycle achieve the same rate. The third blade of the shutter then does nothing but waste light that the projector might well use in fighting the high natural light levels so generously provided by modern architectural design.

Now we have come along with a three-bladed shutter which, thanks to centrifugal force, presents two blades when and only when whirling at sound speed. "Greatest invention since the stem-winding watch," one of our younger and more enthusiastic ad men proclaims it.

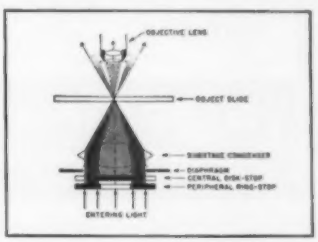
Called the Super-40 Shutter, *it is one of the features that make the three new models of* Kodascope Pageant Sound Projectors *the best movie projection buys which your Kodak Audio-Visual Dealer can show you. Eastman Kodak Company, Cine-Kodak Division, Rochester 4, N. Y., can put you in touch with him if you like.*

Quekett, 1897

Dental chap came in with a live hamster for help in photographing its molars, and when that was done, he asked what's new in photomicrography. We told him about Julius Rheinberg's papers in the *Journal of the Quekett Microscopical Club* for April and November, 1897. Some beautiful Ektachrome photomicrographs of tooth structure have come out of this.

Wratten-Rheinberg is an adaptation of dark-field microscope illumination to introduce color differentiation in colorless objects by means of light rather than stains. It is accomplished by microscope substage filters obtainable at all of $3.75 each from a Kodak dealer, who can order in *Kodak Wratten Rheinberg Differential Color Filters* even though he hasn't heard of them before.

Seven of them are central disk-stops, which consist respectively of a blue (No. 49), green (No. 63), red (No. 70), purple (No. 35), greenish-blue (No. 45A), black (Neutral Density 4), or white matte (thin paper) 15-mm center in a thin 33-mm glass disk. Four of them are peripheral ring-stops with clear 15-mm centers surrounded by 9-mm-wide rings of red (No. 29), blue-green (No. 64), orange (No. 21), or blue (No. 38A). A central and a peripheral disk-stop are placed in tandem in the filter ring of the regular substage condenser, which is focused on the object. Then



one sees things like a red paramecium swimming in a green pool, or vice versa as fancy and good seeing may dictate. Of course, this doesn't work with high-powered objectives that take all the available aperture of the condenser to fill them, in which case you had better look into phase microscopy after all.

There is one more string to the Wratten-Rheinberg bow, however—the luxury model *Sector Stop* for $9.50. It's a peripheral, with alternate 90° sectors of red and blue. Used with the black central disk-stop and lined up with a transversely striated object like a textile, it can make warp red and woof blue.

Slow though the Wratten-Rheinberg technique may be in gaining momentum, we look forward to the avalanche.

Questions about it should go to Eastman Kodak Company, Medical Division, Rochester 4, N. Y.

Prices quoted are subject to change without notice.

This is one of a series of reports on the many products and services with which the Eastman Kodak Company and its divisions are . . . *serving laboratories everywhere*

Kodak

McGRAW-HILL

INDIANS of the NORTHWEST COAST

By PHILIP DRUCKER

Anthropological Handbook Series
American Museum of Natural History

Indians of the Northwest Coast **is written by one of the leading cultural anthropologists in this country, and presents a compact, but highly comprehensive, account of the culture of the Northwest Coast Indians, inhabitants of the vast area bordered to the north by Yukatat Bay in Alaska and to the south by Trinidad Bay on the coast of Northern California.**

The several tribes in this area . . . The Tlingit and Haida in the north, the Tsimshian, Bella Colla, Kwatkiutl, and Nootka further south . . . each with its own distinctive culture, but all sharing enough similarities are considered as a group by Dr. Drucker. The book describes the possible origins, the characteristics, and the achievements of this particularly rich and lively aboriginal culture. Dr. Drucker describes each aspect of this culture—its social structure, its economy, religion and rituals, customs and art—and presents to the general reader a picture of a civilization which is an integral part of the American past.

NOW IN PRESS

OTHER IMPORTANT McGRAW-HILL BOOKS

ROBERT H. LOWIE
INDIANS OF THE PLAINS
222 pages, $4.75

E. ADAMSON HOEBEL
MAN IN THE PRIMITIVE WORLD
543 pages, $6.00

E. ADAMSON HOEBEL, JESSE D. JENNINGS, ELMER R. SMITH
READINGS IN ANTHROPOLOGY
424 pages, $5.00

DR. CLYDE KLUCKHOHN
MIRROR FOR MAN
322 pages, $5.00

McGRAW-HILL BOOK COMPANY, INC.
330 WEST 42ND STREET NEW YORK 36, N. Y.

SEND FOR COPIES ON APPROVAL

(*Continued from page 476*)

24–1. International Council for the Exploration of the Sea, annual, Copenhagen, Denmark. (General Secretary of Council, Charlottenlund Castle, Charlottenlund, Denmark.)

25–30. American Ornithologists' Union, Boston, Mass. (H. F. Mayfield, 2557 Portsmouth Ave., Toledo 13, Ohio.)

27–28. New Mexico Acad. of Science, Albuquerque. (C. C. Hoff, Dept. of Biology, Univ. of New Mexico, Albuquerque.)

27–29. American Ceramic Soc., 8th Pacific Coast Regional, Seattle, Wash. (C. S. Pearce, 4055 N. High St., Columbus 14, Ohio.)

27–29. Electron Microscope Soc. of America, University Park, Pa. (Miss J. R. Cooper, General Electric Co., Lamp Div., Nela Park, Cleveland 12, Ohio.)

27–29. Gerontological Soc., Baltimore, Md. (N. W. Shock, Baltimore City Hospitals, Baltimore 24.)

27–29. Pharmaceutical Industry: Rensselaer Polytechnic Inst. Industrial Council, 5th annual, Troy, N.Y. (F. Tifft, News Bureau, Rensselaer Polytechnic Inst., Troy.)

28–29. Conf. on Rare Earths in Biochemical and Medical Research, Oak Ridge, Tenn. (G. C. Kyker, Oak Ridge Inst. of Nuclear Studies, P.O. Box 117, Oak Ridge.

28–30. American Soc. for Aesthetics, Chicago, Ill. (J. F. White, Western Reserve Univ., Cleveland 6, Ohio.)

30–1. West Virginia Science Fair Work Conf., Weston. (D. E. Large, Science Fair Program, P.O. Box 117, Oak Ridge, Tenn.)

31–1. East Coast Conf. on Aeronautical and Navigational Electronics of Inst. of Radio Engineers, Baltimore, Md. (G. R. White, Bendix Radio Div., Bendix Aviation Corp., Towson 4, Md.)

31–5. Conf. on Solar Energy, Scientific Basis, Tucson, Ariz. (31–1 Oct.); World Symposium on Applied Solar Energy, Phoenix, Ariz. (1–5 Nov.). (M. L. Kastens, Stanford Research Inst., Stanford, Calif.)

November

1–3. Enzymes: Units of Biological Structure and Function, International Symposium, Detroit, Mich. (C. E. Rupe, Henry Ford Hospital, Detroit 2.)

1–5. World Symposium on Applied Solar Energy, Phoenix, Ariz. (M. L. Kastens, Stanford Research Inst., Stanford, Calif.)

2–4. American Documentation Inst., annual, Philadelphia, Pa. (S. Rosenborg, Library of Congress, Washington 25.)

2–4. Society of Rheology, annual, New York. (W. R. Willets, Titanium Pigment Corp., 99 Hudson St., New York 13.)

2–4. Symposium on Antibiotics, 3rd annual, Washington, D.C. (H. Welch, Div. of Antibiotics, Food and Drug Admin., U.S. Dept. of Health, Education, and Welfare, Washington 25.)

2–5. American Soc. of Tropical Medicine and Hygiene, Boston, Mass. (J. E. Larsh, Jr., School of Public Health, Univ. of North Carolina, Chapel Hill.)

3. American Federation for Clinical Research, Midwestern, Chicago, Ill. (R. J. Glaser, Barnes Hospital, 600 S. Kingshighway, St. Louis 10, Mo.)

4–5. Kentucky Academy of Science, Frankfort, Ky. (Mary E. Wharton, Georgetown College, Georgetown, Ky.)

5. Committee for the Scientific Study of Religion, Cambridge, Mass. (R. V. McCann, Andover Hall, Harvard Univ., Cambridge 38.)

6–7. American Soc. for the Study of Arteriosclerosis, 9th annual, Chicago, Ill. (O. J. Pollak, P.O. Box 228, Dover, Del.)

6–13. International Cong. of Allergology, Rio de Janeiro, Brazil. (F. Alves, Avenida Rio Branco 277, 7° andar, Rio de Janeiro.)

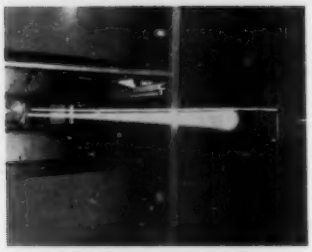
7–9. Assoc. of Military Surgeons of the United States 62nd annual, Washington, D.C. (AMSUS, 1726 Eye St., NW, Washington 6.)

7–9. Eastern Joint Computer Conf., AIEE, IRE, ACM, Boston, Mass. (I. Travis, Burroughs Res. Center, Paoli, Pa.)

7–9. Geological Soc. of America, annual, New Orleans, La. (H. R. Aldrich, 419 W. 117 St., New York 27.)

7–9. Mineralogical Soc. of America, New Orleans, La. (C. S. Hurlbut, Jr., 12 Geological Museum, Oxford St., Cambridge 38, Mass.)

(*See 19 Aug. issue for comprehensive list*)



Below is shown the interior of one of NSEC's modern radiochemical laboratories. Photograph (top) was taken of the cyclotron at the Sara Mellon Scaife Radiation Laboratory at the University of Pittsburgh.

ACCELERATOR-PRODUCED ISOTOPES FOR INDUSTRIAL AND MEDICAL USES

Nuclear Science and Engineering Corporation announces the first industrially integrated program for the production, processing and distribution of accelerator-produced radionuclides. No AEC authorization is required to purchase cyclotron isotopes. Available to any group aware of the nature of the product.

To expedite industrial applications of radioisotopes, NSEC has arranged for irradiations at several cyclotron laboratories to produce radionuclides for commercial distribution.

NSEC now offers an extensive line of accelerator-produced radionuclides. Deliveries will be prompt; prices comparable to AEC rates.

An informative catalog will be sent upon request.

Nuclear Science and Engineering Corporation

P. O. Box 10901, Pittsburgh 36, Pennsylvania

ANNOUNCING . . .

A pioneering work based on a new unifying concept of physics and biology

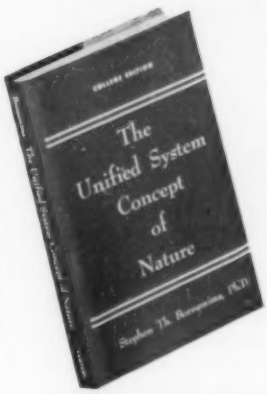
THE UNIFIED SYSTEM CONCEPT OF NATURE:

College Ed.

by Stephen Th. Bornemisza, Ph.D.

Written by an eminent philosopher-physicist, this is a new, significant work on the ultimate composition and operating principles of the world in which we live. Step by step, this new unifying concept of physics and biology is developed—a concept that is important for every scientist and student engaged in basic and other research.

PARTIAL CONTENTS: Causality and randomness. The recurrent changes. The structural changes. The concept of the self-maintaining system. Self-maintaining systems and entropy. The complimentary processes. The unified system pattern of the universe. The system concept and evolution. The fitness of the organic. The reaction of organisms to their space-time environment. The concept of organic image. Evidence of the organic image. Active processes. Passive processes. Harmonic bonds. Psychological aspects of the organic image. The explanation of fitness. Free energy and metabolism. Dysteleology. The definition of life. The origin of life and the formation of organisms and communities. The law of motive power. The systematization of psychophysical phenomena, including a table which for the first time translates experiences and sensations into physical terms, and vice versa. *Published by Vantage Press, 120 W. 31 St., New York 1.*



Just published . . . only $3.00 a copy
Sent on approval—mail coupon

Vantage Press, Inc.,
120 West 31 St., New York 1

Please send me a copy of THE UNIFIED SYSTEM CONCEPT OF NATURE, by Stephen Th. Bornemisza, at $3.00. If not satisfied, I may return it for full refund within 5 days.

☐ Payment enclosed ☐ Send C.O.D.

Name .....

Address .....

City ..... Zone .... State .....

hot air—at temperatures you can depend on

No more worry about "hot" and "cold" spots. This Castle heavy-duty Hot Air Sterilizer has uniform temperatures throughout.

Specially placed baffle-plates and circulation fan provide temperature accuracy of 4°C. at *any setting* between 38°C. and 260°C. Temperature control is fully automatic.

This good uniformity and wide range help you get more precise and controlled results.

Sterilizer built entirely of stainless steel. Heavy 22 gauge. Non-corrosive, heat resistant. Won't warp or buckle. Will give you years of tough service, no matter what your load requirements are.

Double stainless steel walls lined with 2″ of rock wool. Inside size: 30″ x 36″ x 20″. Complete with 3 stainless steel shelves, heater, fan, and motor.

Don't go on depending on uneven sterilization when you can be *sure*. Phone your Castle dealer, or write for Bulletin Q-8.

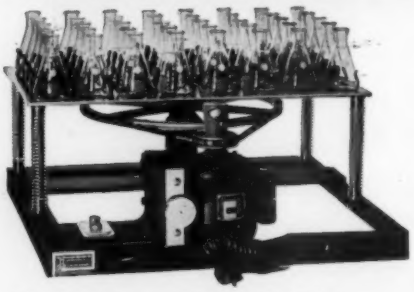
Castle BACTERIOLOGICAL APPARATUS

WILMOT CASTLE CO.

1763 E. HENRIETTA RD., ROCHESTER, N. Y.

Rotary Action

FLASK SHAKER



- Smooth operating, non-creeping and vibration free.
- Variable speed control . . . 160 to 400 oscillations per minute.
- Precision built for continuous operation.
- Versatile for experimentation, research or production.

PRICE $400.00 · · · F O B NEW BRUNSWICK, N. J.

Detailed information available upon request.

NEW BRUNSWICK SCIENTIFIC CO.

PRECISION LABORATORY APPARATUS

P. O. BOX 606 • NEW BRUNSWICK, N. J.

Radio-Active STEROIDS

IMMEDIATELY AVAILABLE

ESTRONE 16-C^{14}
Activity per mg. 2.7 microcuries
Price per mg. $50.00

ESTRADIOL 16-C^{14}
Activity per mg. 2.7 microcuries
Price per mg. $65.00

PROGESTERONE 21-C^{14}
Activity per mg. 2.25 microcuries
Price per mg. $40.00

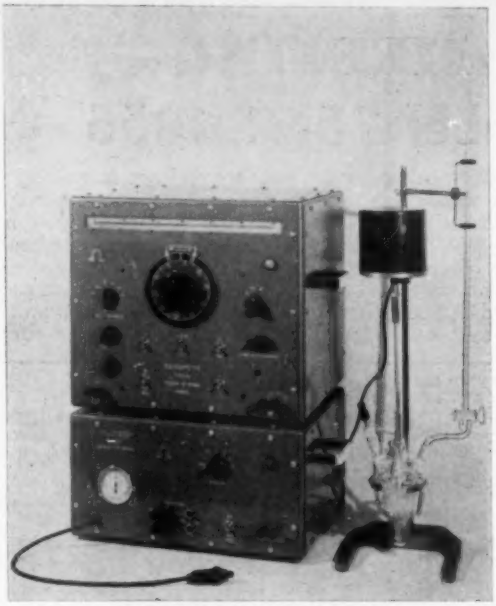
DESOXYCORTICOSTERONE ACETATE 21-C^{14}
Activity per mg. 2.25 microcuries
Price per mg. $40.00

Statement of your government department dealing with atomic energy together with "Atomic Energy of Canada Limited Form No. 247" should be filed with each order.

For these forms and other information, write to:

Charles E. Frosst & Co. . . .
PHARMACEUTICAL and CHEMICAL MANUFACTURERS

P.O. BOX 247
MONTREAL, CANADA



METROHM COULOMETER

A versatile instrument for coulometric analysis where the exact amount of reagent is produced while a reaction takes place. Determination of endpoint by potentiometric, polarographic, conductometric or colorimetric methods.

Also shown on the left are the Metrohm Polarometer and one of their unique Titrating Vessels.

For information on any one of these instruments write to US Distributors

C. A. BRINKMANN & CO.,

378-380 Great Neck Road **Great Neck, L. I., N. Y.**

Now available . . .

Adenosine Triphosphate (ATP); Amygdalin; Amylase; Animal Lecithin; Ascorbic Acid Oxidase; Bacitracin; BAL; Biotin, cryst.; Caffeic Acid; Carotene, cryst.; Catalase; Cellulase; Chlorogenic Acid; Chorionic Gonadotropin; Circulatory Hormone; Colchicine; Cytidylic Acid; Cytochrome C; Dehydroascorbic Acid; Diacetoneamine; Dihydroxyacetone; Dihydroxyphenylalanine (DOPA); Dipyridyl; Edestin; Emulsin; Erythritol; N-Ethylpiperidine; Fibroin; Folic Acid; Galacturonic Acid; Gentistic Acid; Girard Reagents P and T; Gliadin; Glucose Pentaacetate; Glucuronic Acid; Glyceraldehyde; Glyceric Acid; Heparin; Hordenine; Hyaluronidase; Hydrindene; 2-Hydroxyadipaldehyde; Humulon; Indan; Isoascorbic Acid; Isopropylarterenol; Kojic Acid; Kynurenic Acid; Lanthionine; Lipase; Lysozyme; Lyxose; Malononitrile; Maltase; Melezitose; Mesobilirubinogen; Muscle Adenylic Acid; p-Nitrophenylphosphate; Nucleoprotein; Orcinol; Pancreatin; Pantothenyl Alcohol; Penicillinase; Peroxidase; Phenazine; Phenylpyruvic Acid; Phloridzin; Phosphorylase; Piperin; Porphyrindine; Protamines; Protoporphyrin; Pyridoxal; Pyridoxamine; Pyrocatechuic Acid; Pyruvic Aldehyde; Ribonuclease; Saccharic Acid; Salmine; Serine Phosphoric Acid; Spermidine; Spermine; Thioacetic Acid; Thiocytosine; Thyroxine; Trigonelline; Triphenyltetrazolium Chloride; Tripyridyl; Trypsinogen; Tyrosinase; Tyrothricin; Urease; Uricase; Uridine; Vitellin; Xanthosine.

Ask us for others!

DELTA CHEMICAL WORKS, INC.

23 West 60th St. New York 23, N. Y.
Telephone Plaza 7-6317

Depend on Clay-Adams . . .

The *preferred* source of supply for leading hospitals, laboratories and teaching institutions. Quality products through leading scientific dealers everywhere. Our 216-page catalog describes 1161 products.

Clay-Adams

141 East 25th Street • New York 10

Look for these familiar trade names—your assurance of quality!
Adams Centrifuges • Yankee Rotators • Gold Seal Slides and Cover Glasses • Adams Laboratory Counters • Counting Chambers
Yankee Shakers • Medichromes

APPLICATION FOR HOTEL RESERVATIONS

122nd AAAS MEETING

Atlanta, Ga., December 26-31, 1955

The list of hotels and their rates and the reservation coupon below are for your convenience in making your hotel room reservation in Atlanta. Please send your application, *not* to any hotel directly, but to the AAAS Housing Bureau in Atlanta and thereby avoid delay and confusion. The experienced Housing Bureau will make assignments promptly; a confirmation will be sent you in two weeks or less. **As in any city, single-bedded rooms may become scarce; double rooms for single occupancy cost more; if possible, share a twin-bedded room with a colleague—and also save money.** Mail your application *now* to secure your first choice of desired accommodations. All requests for reservations must give a definite date and estimated hour of arrival, and also probable date of departure.

HOTELS AND RATES PER DAY

★ **Hotels starred have sessions in their public rooms.** Most hotels will place comfortable rollaway beds in rooms or suites at 2.50 or 3.00 per night. For a list of headquarters of each participating society and section—and for information on **dormitory accommodations** at Atlanta University and Georgia Institute of Technology—please see *Science*, July 22, or *The Scientific Monthly*, August.

Hotel★	Single	Double Bed	Twin Bed	Suite
Georgia Tech Zone				
Atlanta Biltmore★	6.00–10.00	8.00–14.00	10.00–14.00	15.00–50.00
Cox-Carlton	4.00– 6.00	6.00– 8.00	6.00– 8.00	14.00–16.00
Georgian Terrace	5.00– 8.00	8.50–11.00	8.50–12.00	12.00–22.00
Peachtree Manor	5.00– 8.00	7.50– 9.50	8.50–12.00	15.00–28.00
Downtown Zone				
Atlantan	4.00– 5.50	6.00– 8.50	8.50–10.50	17.00
Dinkler Plaza★	6.00– 8.50	7.00–11.50	13.00–15.00	12.00–35.00
Georgia★	4.00– 7.00	6.00– 9.00	7.00–10.00	15.00–20.00
Hampton	2.50– 4.00	3.50– 5.00	5.00– 7.00	
Henry Grady★	5.50–12.00	9.00–12.00	9.50–12.00	16.00–25.00
Imperial	4.00– 5.50	6.00– 6.50	6.50– 7.00	
Jefferson	3.00– 3.50	4.00– 5.00	4.50– 5.00	
Peachtree on Peachtree	5.00– 7.00	7.50–10.50	8.50–10.50	10.00–18.00
Piedmont★	5.50– 8.00	7.50–10.00	10.00–14.00	20.00–25.00
As required by local laws, the following are available for Negro members and visitors:				
Royal Hotel 214 Auburn Ave., N.E.	4.00	5.00		
Savoy Hotel 239 Auburn Ave., N.E.	2.50	3.50– 4.50		
University Motel 55 Northside Drive, N.W.	5.00	8.00		

THIS IS YOUR HOTEL RESERVATION COUPON

AAAS Housing Bureau
Room 912, Rhodes-Haverty Bldg.
Atlanta 3, Ga.

Date of Application .....

Please reserve the following accommodations for the 122nd Meeting of the AAAS in Atlanta, Dec. 26–31, 1955:

TYPE OF ACCOMMODATION DESIRED

Single Room ..... Desired Rate ..... Maximum Rate .....

Double-Bedded Room ..... Desired Rate ..... Maximum Rate ..... Number in party .....

Twin-Bedded Room ..... Desired Rate ..... Maximum Rate .....

Suite ..... Desired Rate ..... Maximum Rate ..... Sharing this room will be:

(Attach list if this space is insufficient. The name and address of each person, including yourself, must be listed.)

.....

.....

First Choice Hotel ..... **Second Choice Hotel** ..... **Third Choice Hotel** .....

DATE OF ARRIVAL ..... DEPARTURE DATE .....
(These must be indicated—add approximate hour, a.m. or p.m.)

NAME .....
(Individual requesting reservation) (Please print or type)

ADDRESS .....
(Street) (City and Zone) (State)

Mail this now to the Housing Bureau. **Rooms will be assigned and confirmed in order of receipt of reservation.**

AN INTRODUCTION TO

STOCHASTIC PROCESSES

by M. S. Bartlett

A GENERAL survey of the new mathematical and statistical techniques for studying stochastic processes (any processes that have some statistical or chance element in their structure, such as the phenomenon of Brownian motion, the growth of a bacterial colony, or the fluctuating numbers of electrons and photons in a cosmic ray shower). As processes of this kind are of universal occurrence, the book will interest a wide range of specialists. The general mathematical methods developed in the early chapters form the basis for any applications, physical or biological.

$6.50, at your bookseller's

CAMBRIDGE UNIVERSITY PRESS
32 East 57th Street, New York 22, N. Y.

- **Cetyl Dimethyl Benzyl Ammonium Chloride**
- **Chloracetopyrocatechol**
- **6, 9 Dichloro-2-Methoxyacridine**
- **5-Diethyl-2-Aminopentane**
- **Diethylacetamidomalonate**
- **Diethylbenzamidomalonate**
- **Diphenylacetonitrile**
- **Ethyl Acetamidocyanoacetate**
- **Ethyl Oxalpropionate**
- **Gitoxin**
- **Gramine**

For the rest of the Winthrop Alphabet send for our 1955 price list.

WINTHROP

Winthrop-Stearns INC.
SPECIAL CHEMICALS DIVISION
1450 Broadway, N. Y. 18

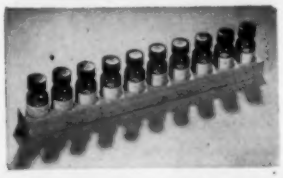
LaMOTTE pH BLOCK COMPARATOR

This improved LaMotte Unit greatly facilitates simple, accurate, Hydrogen Ion Control. It is especially recommended for the use of individual operators on any step of a process where a definite pH value must be maintained. Even with highly colored or turbid solutions determinations can easily be made with accuracy.

The new plastic block comparator is non-corrodible, moisture-resistant, and has more sharply defined color fields.

Complete with any one set of LaMotte Permanent Color Standards, together with a supply of the corresponding indicator solution, measuring pipette and marked test tubes.

LaMOTTE WATER SOLUBLE pH INDICATORS
(Sulfon-phthalein series) pH 0.2–9.6



These products were originally developed in the LaMotte laboratories and are of the same superior quality as the acid form indicators hitherto available for pH work.

They have the distinct advantage of being instantly soluble in distilled water, hence are easy to convert to solution form. Use of alkali, as required in the older technic, is eliminated, and no heating is necessary.

The clean quick way to prepare indicator solutions for accurate pH work.

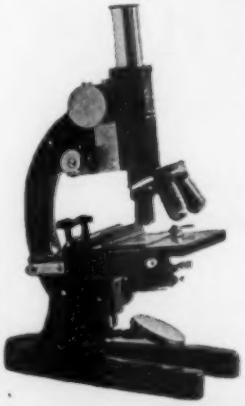
LaMotte Chemical Products Company
Dept. "H" Towson 4, Md.

GRAF APSCO

MONOCULAR
BINOCULAR
MICROSCOPES

FUNCTIONALLY DESIGNED

Safety features designed into the instrument
Write for new catalogue



MODEL GKM3

with
5 and 10X oculars
Achromatic Objectives
16mm. (10X) N.A. 0.27
4mm. (44X) N.A. 0.66
1.8mm. (100X) N.A. 1.3
Graduated mechanical stage and rack and pinion type Abbe condenser.
With carrying case.

$255.00 each
less 10% on 5 or more. Transportation charges included.

THE GRAF-APSCO CO.
5868 BROADWAY CHICAGO 40, ILL.

PERSONNEL PLACEMENT

YOUR ad here reaches over 32,000 foremost scientists in the leading educational institutions, industrial laboratories, and research foundations in the U. S. and 76 foreign countries —at a very low cost.

CLASSIFIED: 18¢ per word, minimum charge $3.60. Use of Box Number counts as 10 additional words.

DISPLAY: Rates listed below — no charge for Box Number. Monthly invoices will be sent on a charge account basis—provided that satisfactory credit is established.

Single insertion	**$19.50 per inch**
7 times in 1 year	**17.50 per inch**
13 times in 1 year	**16.00 per inch**
26 times in 1 year	**14.00 per inch**
52 times in 1 year	**12.50 per inch**

For PROOFS on display ads, copy must reach SCIENCE 4 weeks before date of issue (Friday of every week).

POSITIONS WANTED

Bacteriologist; Ph.D., January 1; experience in bacterial physiology, radiobiology, aerosol bacteriology, and other areas of general bacteriology. Well grounded in statistics and experienced user of radioisotopes; desires teaching and/or research. Box 239, SCIENCE. X

Bacteriologist; recent Ph.D.; highly qualified medical bacteriology, mycology; research experience with phages, animal viruses; chemistry background; publications; desires position in research, teaching, or industry. Box 240, SCIENCE. X

Chemist, organic; M.S. equivalent, minor biochemistry; 3 years food research and development, 4 years industrial experience; desires to work on research team; age 33; family. Box 236, SCIENCE. 9/9

Chemist; Ph.D.; nearly 20 years experience; noted pharmaceutical houses; now research director, pharmaceutical production, large Eastern concern; outstanding scientist thoroughly grounded in pharmaceutical development. Woodward Medical Bureau, 185 N. Wabash, Chicago. X

Microbiologist; Ph.D., 32; teaching, research and administrative experience in university medical school and government research organization; microbial physiology, general bacteriology, biochemistry, nutrition, isotopes; publications; desires responsible administrative and research position. Box 241, SCIENCE. 9/16

Zoologist; Ph.D. Serology, M.A. Parasitology; 4 years teaching, field and laboratory research; desires academic position. Box 238, SCIENCE. X

POSITIONS WANTED

(a) **Physician**, Ph.D. (Physiology, Pharmacology); 6 years teaching; 8 years, director, department of pharmacology, pharmaceutical company. (b) **Physiologist**; Ph.D., Princeton; 4 years teaching; 7 years, director of research, pharmaceutical company, Medical Bureau (Burneice Larson, Director), Palmolive Building, Chicago. X

Physiologist; Ph.D. 1950; cellular physiology background; experience in histochemistry and reproductive physiology; wide interests; publications; references; desires academic and/or research position. Box 243, SCIENCE. X

POSITIONS OPEN

(a) **Analyst**; product development laboratory, well-known concern; M.S. preferred; thorough chemistry training; principal duty study new product stability; perform necessary assays, assess results; Midwest. (b) **Chemist**; recent graduate; one of country's finest hospitals; East. (c) **Senior Bacteriologist**; city public health laboratory; degree and 4 years experience required; about $5000; ideal resort city; East. (d) **Pharmacist**; Ph.D. trained in chemistry, biochemistry, pharmacology; must be thoroughly grounded in pharmacy, especially techniques of industrial pharmacy; product development laboratory; Mideast. (e) **Biochemist**; Ph.D. to head laboratory service, new diagnostic clinic; direct laboratory technicians; research in enzyme, steroid, chemistry; new facility; $8000; Mideast. Woodward Medical Bureau, 185 N. Wabash, Chicago. X

Biochemist; Ph.D.; clinical chemist preferred; 225-bed general hospital in New England; assist in interne-resident, medical technology training programs; possible teaching association with university. Box 235, SCIENCE. 9/9

Biochemist; interesting positions with the City of Philadelphia; Civil Service security benefits and promotons; positions on three levels with starting salary of $3750, $4710, $5916 per year; requirements vary according to level. For further information contact: Applications Office, Room 127, City Hall, Philadelphia 7, Pa. X

(a) **Physician**, preferably with several years of private practice, to join professional staff, pharmaceutical company and, also, physician qualified for clinical investigations of new drugs; East. (b) **Head, pharmacology department**, university affiliated research institution; program calls for interest in chemotherapy of neoplastic disorders and metabolic antagonists; one oriented toward academic and investigative pharmacology required; East; $8000–$10,500. (c) **Physiologist**, qualified teach in medical physiology laboratory, large university; instructor or assistant professor. S9-2 Medical Bureau (Burneice Larson, Director), Palmolive Building, Chicago. X

POSITIONS OPEN

Ph.D. or equivalent, recent, for research in pharmacology, ethical pharmaceutical company in New York City; good opportunity for man preferring small organization. Please state salary expected. All replies acknowledged. Box 228, SCIENCE. 9/9

Excellent opening for man or woman skilled in plant microtechnique to head production of botanical slides. Give complete outline of training and experience in application letter. Carolina Biological Supply Company, Elon College, North Carolina. 9/9, 16

Information specialist; needed by research group in field of animal nutrition and veterinary medicine. Duties: to conduct literature searches, maintain an abstract bulletin, and assist in preparing technical reports. Training in chemical and biological sciences essential as well as some facility in writing and familiarity with technical literature; locaton Midwest. Please state full details and minimum salary requirement in first letter to Box 242, SCIENCE. X

SCIENTISTS FOR OCEANOGRAPHIC RESEARCH

With Master's or Doctor's degree in physics, geophysics, biophysics, or mathematical physics. Experience and interest in marine research desirable. For detailed information write for interview appointment with member of scientific staff. Please send your personnel résumé.

WOODS HOLE OCEANOGRAPHIC INSTITUTION
WOODS HOLE, CAPE COD, MASSACHUSETTS

GRANTS

1956 Research Grants

The Arctic Institute of North America is offering research grants in 1956 for scientific investigations dealing with the arctic and subarctic regions of North America. Applications for research grants are invited from those who have demonstrated their ability to conduct research work of superior quality in some field of science. Proposals in the broad field of the earth sciences, in marine biology, and in physiology are especially invited. Facilities of the Arctic Research Laboratory at Barrow, Alaska, including housing and equipment, are available to scientists for both summer and winter investigations. Completed applications should be received before 1 November, 1955. For information and forms write Arctic Institute of North America, 1530 P. Street, N.W., Washington 5, D.C., or 3485 University Street, Montreal 2, Quebec, Canada.

The MARKET PLACE

BOOKS • SERVICES • SUPPLIES • EQUIPMENT

DISPLAY: Rates listed below—no charge for Box Number. Monthly invoices will be sent on a charge account basis —provided that satisfactory credit is established.

Single insertion	**$19.50 per inch**
7 times in 1 year	**17.50 per inch**
13 times in 1 year	**16.00 per inch**
26 times in 1 year	**14.00 per inch**
52 times in 1 year	**12.50 per inch**

For PROOFS on display ads, copy must reach SCIENCE 4 weeks before date of issue (Friday of every week).

BOOKS AND MAGAZINES

WANTED TO PURCHASE . . .

SCIENTIFIC PERIODICALS and BOOKS — Sets and runs, foreign and domestic. Entire libraries and smaller collections wanted

WALTER J. JOHNSON • 125 East 23rd St., New York 10, N. Y.

Your sets and files of scientific journals

are needed by our library and institutional customers. Please send us lists and description of periodical files you are willing to sell at high market prices. Write Dept. A3S, F. S. CANNER, INC. Boston 19, Massachusetts

BOOKS AND MAGAZINES

WANTED: BOOK MANUSCRIPTS

A publisher with high standards will be happy to read your manuscript on any subject, scientific or general. Intelligent editing, emphasis on book sales, a fair, honest cooperative contract if your work is acceptable. Write, or mail your manuscript directly, without obligation.

GREENWICH BOOK PUBLISHERS, INC.
Atten. MR. INMAN 489 FIFTH AVE.
NEW YORK 17, N. Y.

PROFESSIONAL SERVICES

CONSULTATION RESEARCH

MICROBIOLOGY
PHARMACOLOGY
BIOCHEMISTRY
TOXICOLOGY
ANIMAL HISTOPATHOLOGY

SOUTH SHORE
ANALYTICAL AND RESEARCH LABORATORY, Inc.
148 ISLIP AVE. ISLIP, N. Y.

The MARKET PLACE

BOOKS • SERVICES • SUPPLIES • EQUIPMENT

PROFESSIONAL SERVICES

RESEARCH SERVICE

Fungicide Testing and Evaluation
Soil Burial — Agar Tests
Chemical Analysis — Leaching

Applied Science Laboratories, Inc.
140 N. Barnard St., State College, Pa. Phone AD 8-6282

BOOK MANUSCRIPTS INVITED

Write for Free Booklet SC telling how we can publish your book. All subjects considered. New authors welcome.
VANTAGE PRESS, Inc. • 120 W. 31 St., New York 1
In Calif.: 6253 Hollywood Blvd., Hollywood 28

WISCONSIN ALUMNI RESEARCH FOUNDATION

LABORATORY SERVICES

Project research and consultation in Biochemistry, Chemistry, Bacteriology and Entomology

Amino acid assays and biological protein evaluations • Vitamin and antibiotic assays • Chick feeding tests • Pharmacology including warm-blooded toxicity studies • Phenol coefficient determinations

Write for price schedule

WISCONSIN ALUMNI RESEARCH FOUNDATION
P. O. BOX 2059-V • MADISON 1, WISCONSIN

FOOD RESEARCH LABORATORIES, INC.
Founded 1922
Philip B. Hawk, Ph.D., President
Bernard L. Oser, Ph.D., Director
Research • Analyses • Consultation
Biological, Nutritional, Toxicological Studies for the Food, Drug and Allied Industries
48-14 33rd Street, Long Island City 1, N.Y.

• RESEARCH
• CONSULTATION
• ANALYSES

SUPPLIES AND EQUIPMENT

RATS Long-Evans (PAF) Wistar (PAF)

Bred for Research Work by Research Workers

PACIFIC ANIMAL FARMS
2457 Fletcher Dr., Los Angeles 39, Calif.

RESEARCH BIOCHEMICALS

OVER 1500

NUTRITIONAL BIOCHEMICALS Corp.
Cleveland 28, Ohio

Write for your copy—free catalogue—Dept. 102

• HYPOPHYSECTOMIZED RATS

Shipped to all points via Air Express
For further information write
HORMONE ASSAY LABORATORIES, Inc. • 8159 South Spaulding Ave. Chicago 29, Ill.

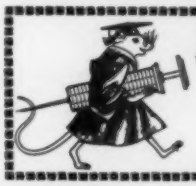
SUPPLIES AND EQUIPMENT

Guinea Pigs | Rats from the Wistar Strain | Hamsters

Laboratory Animals since 1929

ALBINO FARMS
PO Box 331
RED BANK, NEW JERSEY
Swiss Mice — Albino Rabbits

All AMINO ACIDS — natural, synthetic, unnatural. Rare Sugars, Biochemical Products, Reagents, New Pharmaceuticals in stock. Write or phone Plaza 7-8171 for complete price list.
BIOS LABORATORIES, INC. 17 West 60th Street, New York 23, N. Y.



SWISS MICE
TACONIC FARMS
GERMANTOWN NEW YORK
GERMANTOWN 3535

GME
714 MARKET PLACE
MADISON 3, WIS.

FRACTIONATORS • TRANSFERATORS
CARDIOVASCULAR RECORDERS
ELECTROENCEPHALOGRAPHS
WARBURG APPARATUS
WATER BATHS

Specifically Labeled
SUGARS & OTHER — C^{14} COMPOUNDS. Compare our prices.
Orlando Research, Inc. P. O. Box 6491 Orlando, Fla.

for
• MICROSCOPES
• MICROTOMES
• ILLUMINATORS
Specializing in equipment made in all Zeiss and Leitz factories
Write to
ERIC SOBOTKA CO. • 102 West 42d Street New York 36, N. Y.

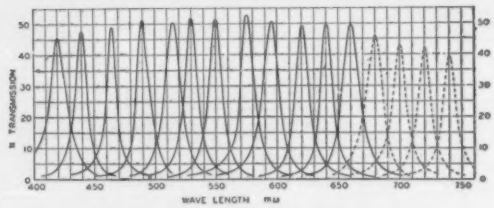
ALBINO RATS* *"From the hand of the veterinarian to research"*

HYPOPHYSECTOMIZED RATS
*Descendants of the Sprague-Dawley and Wistar Strains

HENRY L. FOSTER, D.V.M.
President and Director
THE CHARLES RIVER BREEDING LABS.
Wilmington, Mass.

BALZERS Interference Filters

for isolating narrow spectral bands



Spectral Range: 400-900 millimicrons
Spectral Width: 12-15 mμ, Transm.: 45-50%
Size: 2″ x 2″. Other sizes on order.

For
Flame Photometry and Color Densitometry
Microscopy and Photomicrography
Colorimetry and Fluorimetry

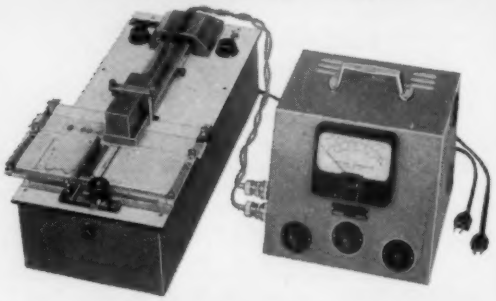
also in reflectometry, light scattering measurements, microcolorimetry, refractometry, polarimetry, and in all other fields requiring monochromatic light in the visible and near-infrared range.

Write for Bulletin #180 to

PHOTOVOLT CORP.
95 Madison Ave. New York 16, N. Y.

PHOTOVOLT Densitometer

for Partition Chromatography and Paper Electrophoresis



A photoelectric precision instrument for the rapid and convenient evaluation of strips and sheets of filter paper in partition chromatography and paper electrophoresis.

Write for Bulletin #800 to

PHOTOVOLT CORP.
95 Madison Avenue New York 16, N. Y.

Also

Colorimeters	pH meters	Electronic Photometers
Fluorimeters	Reflection Meters	Multiplier Photometers
Nephelometers	Glossmeters	Interference Filters

AIR CONDITIONED TEST CABINET

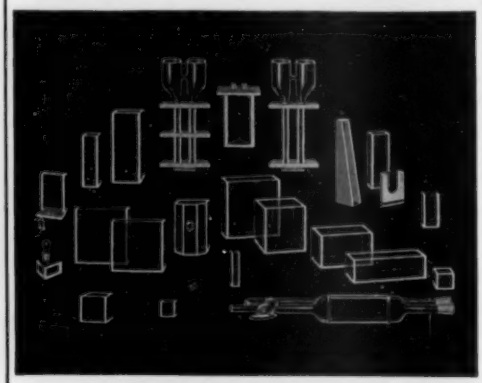
RANGE—up to 150° F (dry bulb). With refrigeration, dew point temperatures as low as minus 30° F. Control of relative humidity from 5% to 95% is obtained at all temperatures in this range. Air capacity is 200, 400 or 600 c. f. m. Dimensions are 30″ x 28″ x 24″.

METHOD—Air is saturated in the air-conditioning unit at the required dew point temperature and reheated to the desired dry bulb temperature. No moisture sensitive instruments are needed. Recorders obtain a complete record of conditions.

Write for complete information. Address Dept. SW.

NIAGARA BLOWER COMPANY
405 Lexington Ave., New York 17, N. Y.

GLASS ABSORPTION CELLS made by KLETT

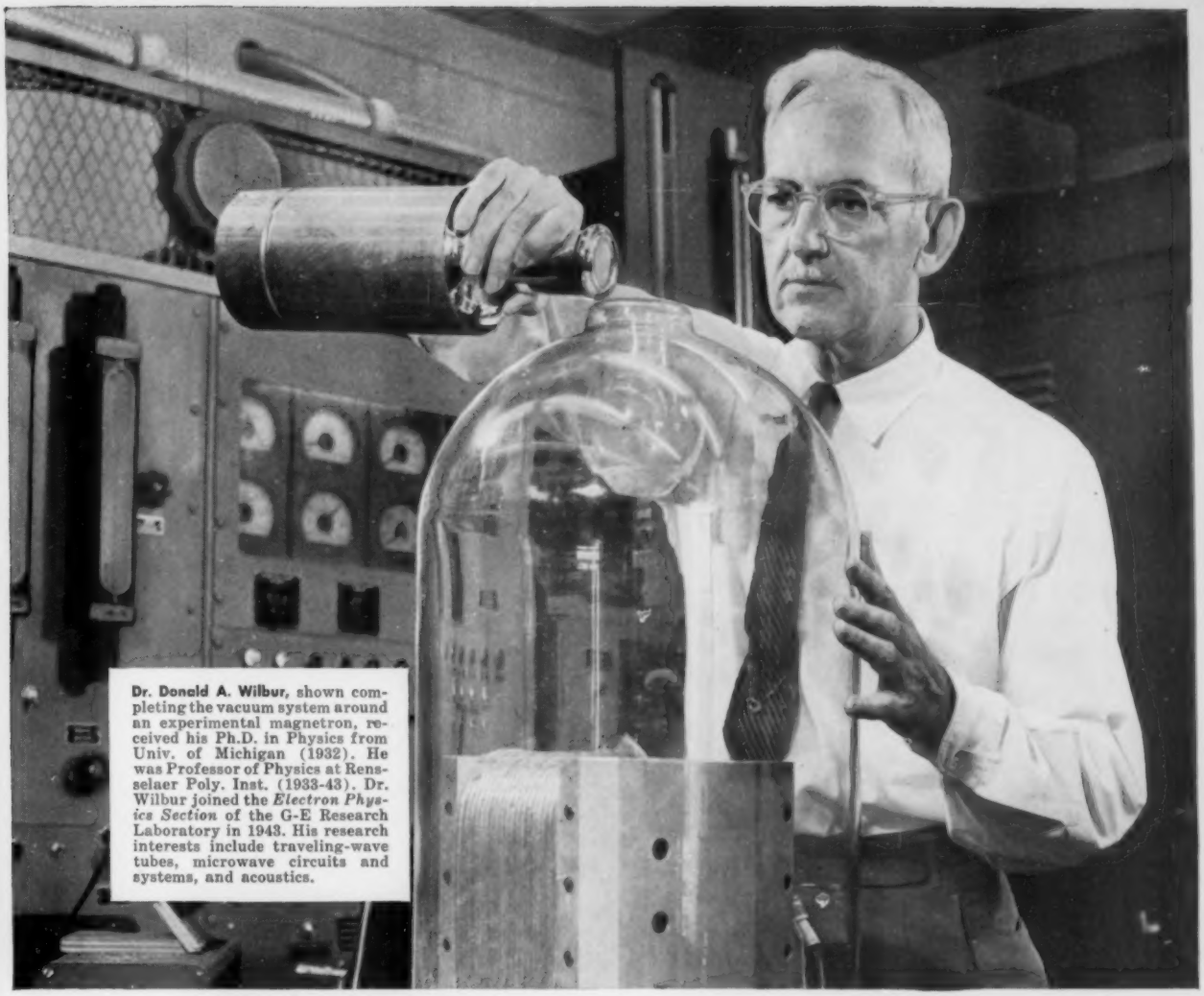


Makers of Complete Electrophoresis Apparatus

SCIENTIFIC APPARATUS

Klett-Summerson Photoelectric Colorimeters—Colorimeters — Nephelometers — Fluorimeters—Bio-Colorimeters — Comparators — Glass Standards—Klett Reagents.

Klett Manufacturing Co.
179 East 87 Street, New York, New York



Dr. Donald A. Wilbur, shown completing the vacuum system around an experimental magnetron, received his Ph.D. in Physics from Univ. of Michigan (1932). He was Professor of Physics at Rensselaer Poly. Inst. (1933-43). Dr. Wilbur joined the *Electron Physics Section* of the G-E Research Laboratory in 1943. His research interests include traveling-wave tubes, microwave circuits and systems, and acoustics.

Rapid tuning for magnetrons

General Electric's Dr. D. A. Wilbur experiments with non-mechanical, electronic tuning methods

General Electric's interest in ultrahigh-frequency wave generators dates back to the pioneer work of Dr. Albert W. Hull, who invented the original magnetron in 1921. The subsequent role played by magnetrons in military radar is now familiar history. But until recently, tuning magnetrons over a broad range had to be accomplished mechanically; and this was a major problem, since space was limited within the vacuum envelope. Also, the required mechanical linkage made tuning a slow and cumbersome operation.

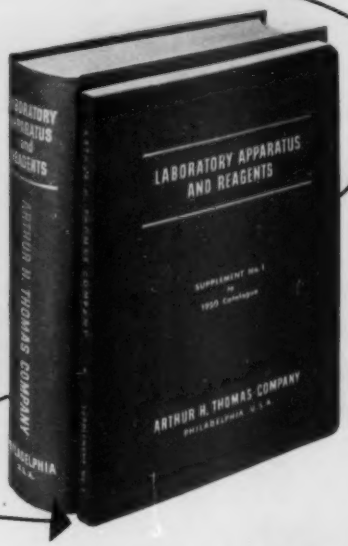
Dr. Donald A. Wilbur and his associates at the General Electric Research Laboratory have discovered how to tune magnetrons by varying the DC supply voltage. Because this method is electronic—rather than mechanical— the tuning can now be enormously speeded, permitting the use of magnetrons in many new automatic testing devices. As a result of this work by General Electric scientists, electronic tuning may soon be adapted to radar, television and radio broadcasting, and for testing the components of communications networks.

Progress Is Our Most Important Product

GENERAL ELECTRIC

Now being distributed . . .

SUPPLEMENT
to the
THOMAS CATALOGUE



1600 New Items

Current Price List

NOW . . . 22,000 items offered to you for immediate shipment from our stock.

This new Supplement follows the tradition of the Thomas catalogue on which the following comment was made by a leading scientific periodical:

"More than a catalogue . . . a source of reference the user will place on his shelves with manuals and textbooks"

The encyclopedic catalogue of 1472 pages and the new 264-page supplement list a total of approximately 22,000 current items, adequate stocks of which are carried for immediate shipment.

The selection of apparatus is based upon more than half a century of experience in supplying the needs of laboratories of Chemistry and Biology, both large and small. Choice was made after careful consideration, and testing by the Thomas technological staff. Items included are therefore offered with assurance of being satisfactory for the purpose intended.

This new Supplement with current Price List, in combination with the general catalogue, constitutes an up-to-date listing of one of the most comprehensive assortments of apparatus and reagents available from any single source.

SUPPLEMENT

Detailed and factual listings, fully indexed, of new items added to our stock since 1950.

Complete "Price List" of current apparatus items in *both* catalogue and supplement.

Supplement now being mailed to all who have the Thomas catalogue.

SYMBOL OF QUALITY
A.H.T.CO.
SPECIFICATION
LABORATORY APPARATUS

ARTHUR H. THOMAS COMPANY

Laboratory Apparatus and Reagents

WEST WASHINGTON SQUARE PHILADELPHIA 5, PA.

Telatype Services: Western Union WUX and Bell System PH-72